CYCLOPÆDIA

OF THE

PRACTICE OF MEDICINE.

EDITED BY DR. H. VON ZIEMSSEN,
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VOL. I.

ACUTE INFECTIOUS DISEASES.

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PREFACE TO THE ENGLISH TRANSLATION.

For some time past physicians, both in this country and abroad, have felt the need of a work, or series of works, which should furnish a complete picture of the present state of medical knowledge in the departments of etiology, pathology, and treatment. The ordinary text-books do not supply this want, and the busy practitioner cannot afford to spend either time or money upon the scores of monographs which are constantly being published. A series of treatises, however, written by men who are skilled in the different departments of medicine, and published in such a form as to make, when completed, a compendium of reference, would meet in great measure this demand. Such is the character of the work which has been begun in Germany, and which is now being published in the English language.

Most readers, I think, will unite with me in according praise to the different translators of this volume for the satisfactory manner in which they have accomplished their difficult tasks.

The differences in the German, British, and American pharmaceutical preparations, and systems of weights and measures, have also offered certain difficulties, to obviate which, and to obtain uniformity, Dr. Edward Curtis, Professor of Materia Medica in the College of Physicians and Surgeons, New York, has kindly undertaken the supervision of the sections relating to treatment.

The carefully prepared Index at the end of the volume is the work of Dr. Charles Laight, of New York.

A. H. B.

BIOGRAPHICAL SKETCHES OF THE AUTHORS.*

Hugo Wilhelm von Ziemssen, the Editor, was born December 13th, 1829, at Greifswald, on the Baltic Sea. After having finished his studies at the High School (gymnasium) of his native town, he studied medicine at Berlin in 1849, at Würzburg in 1850 and 1851, and at Greifswald in 1852 and 1853, from which latter university he received the degree of Doctor of Medicine in 1853. In 1856 he was appointed Assistant Physician to the medical clinic and polyclinic at Greifswald, and also a Private Instructor in medicine.

He was elected an Extraordinary Professor in 1861; in 1863 he responded to a call from Erlangen, where he maintained the position of Professor to the medical clinic, until the spring of 1874, when he changed his field of activity for the university at Munich. At present he holds the Professorship of Clinical Medicine, and is director of the City General Hospital at the latter place.

Of his contributions to medical literature the following have been published:

Electricity in Medicine. Berlin: Hirschwald, 1857. 2d Ed. 1864; 3d Ed. 1866; 4th Ed. 1872.

On Paralysis of the Cranial Nerves. Virchow's Arch., Vol. XIII. 1857.

Etiology of Uterine Tumors. Virchow's Arch., Vol. XVII. 1859.

Pleurisy and Pneumonia in Childhood. A monograph. Berlin: Hirschwald, 1866.

In 1862 he founded the "Greifswald Medical Reports," editing them with the support of the medical faculty, until 1864. They contain the following essays from his pen:

Clinical Study of Measles and its Complications, with Special Reference to the Relations of Temperature. (In connection with Dr. Shrabler.) Vol. I. 1863.

Artificial Respiration in the Asphyxiated, by means of Faradic Irritation of

* Very kindly furnished by Prof. von Ziemssen for the American edition.

the Phrenic and Associate Nerves. Asphyxia from the Inhalation of Illuminating Gas. Vol. I. 1863.

Dermatological Studies (I. Sycosis parasitica.—II. Area Celsi) Vol. II. 1864.

Artificial Respiration in the Asphyxiated. Ibidem.

A Laryngoscopic Case of Croup. Ibidem.

Lead Poisoning from Snuff, with extensive Paralysis. Ibid.

An Epidemic of Variola. Vol. III. 1865.

In 1865, Ziemssen, in connection with Prof. Zenker, founded the "Deutsche Archiv für Klin. Medicin." His contributions to the same are

Clinical Observations of Epidemic Cerebro-spinal Meningitis. (In connection with Dr. Hess.) Vol. I. 1865.

The Methodical Diaphoretic Treatment of Dropsy. Vol. II. 1866.

Laryngoscopy and Laryngo-therapeutics. Vol. IV. 1868.

Paralysis of the Vocal Cords. Ibidem.

On Variations of the Electric Irritability in Peripheric Paralysis. (In connection with Dr. Hess.) Ibid.

Thoracentesis in Hydrothorax. Vol. V. 1869.

The School of Salerno and the Physicians of the Middle Ages. Vol. IX. 1872.

The Technique of Local Treatment of the Stomach. Vol. X. 1872.

On Clinical Instruction in Germany. Vol. XIII. 1874.

Karl Liebermeister, born in 1833 in Ronsdorf, near Elberfeld, studied medicine in Bonn, Würtzburg, Greifswald, and Berlin. In 1858 he was made Assistant Physician, and in 1859 Instructor at Greifswald; in 1860 he accompanied Niemeyer as his assistant to Tübingen, where he was created Extraordinary Professor of Pathological Anatomy, then advanced to the Professorship of Clinical Medicine in Basle, and in 1871 to the same position in Tübingen. The following are his contributions to medical literature:

Contributions to the Pathological Anatomy and Pathology of Hepatic Diseases. Tübingen. 1864.

Observations on the Use of Cold Water in Febrile Diseases. (In connection with Dr. Hagenbach.) Leipzig: Vogel, 1868.

Numerous articles on Fever and its Treatment, Bright's Disease, Typhoid Fever, etc., are contained in the "Deutsche Archiv. für Klin. Medicin," in the "Prager Vierteljahresschrift," "Berliner Wochenschrift," "Volkmann's Sammlung Klinischer Vorträge," etc., etc.

Prof. H. Lebert was born in Breslau in 1813, and received his preliminary education in Berlin. He entered upon his university studies in the spring of

1831, and successively attended the schools of Berlin, Zürich, and Paris. He received his medical degree in Zürich, and resided in Switzerland until 1846, when he commenced practice in Paris. In 1853 he was called to Zurich, to fill the Professorship of Clinical Medicine. In 1859 he was called to Breslau, where he has remained until quite recently. At the present time he is practising as consulting physician in Vevay, Switzerland; a large part of his time being devoted to medical literature and the natural sciences.

His earliest contributions to medical literature were of a physiological and physiologico-pathological character, and had reference especially to the origin and development of morbid growths. In 1845, his "Physiologie Pathologique" was published in Paris; in 1849, his "Traité des Maladies Scrofuleuses et Tuberculeuses;" in 1851, his "Traité des Maladies Cancéreuses;" in 1854–1863, his great work on pathological anatomy (four folio volumes, two with plates). He has also contributed largely to German medical literature, for, besides many smaller articles in "Müller's Archiv," he has published a series of articles on comparative anatomy; in 1848, his surgical essays; from 1858–70 the four editions of his "Treatise of Practical Medicine;" and in 1872, his "Klinik der Brustkrankheiten."

His researches in the domain of natural science during latter years have had reference to various questions in Palæontology, in the botany of the lower orders of plants, and in Zoology, especially of the Arachnidæ.

Dr. Fritz Haenisch was born in Greifswald in 1842, and completed his course of studies at the "Gymnasium" in 1860. He then devoted himself to the study of medicine at Würtzburg and Greifswald; graduated in 1864, and underwent his state examination during the winter of 1864–65. After having officiated for one year in the capacity of Assistant Physician to the University Infirmary, under Prof. Bardeleben, he served as surgeon during the war against Austria, in 1866. After this he went abroad and attended the universities of London, Edinburgh, Dublin, Paris, and Vienna; on his return he obtained the position of Assistant Surgeon in the navy. As such he had the opportunity of visiting the Mediterranean, Madeira, the West Indies, South and North America, the Azores, and Portugal. He returned in 1871 from this expedition, began the practice of medicine in his native town, and also established himself as Instructor at the university, at the same time officiating as Assistant Physician to the polyclinic, under Prof. Mosler. His lectures comprised laryngoscopy, physical diagnosis, and clinical medicine. During the last years he has published articles on yellow fever, herpes zoster, bronchial asthma, and pneumatic treatment, in the "Deutsche Arch. f. klin. Medicin."

Prof. Heubner was born in 1843, in Mühltroff, in Saxony. From 1861 till 1866 he studied medicine at Leipzig. During the summer of 1866 he completed his studies at Vienna. From 1866 till 1871 he officiated as Clinical Assistant in the Leipzig Infirmary, at Wunderlich's clinic. In 1868 he became an Instructor at the university. In 1873 he was elected Extraordinary Professor, which position he holds at the present time. His branch is Special Pathology and Therapeutics, and he holds a clinic at the Infirmary on Clinical Diagnosis. His thesis was entitled: "Incomplete Reaction after an Attack of Cholera" (epidemic of 1866). In addition, in 1868, he wrote on "Sinus Thrombosis;" in 1870 "On the Physiological Action of Camphor," also on "Syphilis of the Brain;" in 1871 on "Typhoid Fever," and some other internal diseases, which he observed during the war (Contributions to Military Medicine). All these papers appeared in the "Archiv der Heilkunde." During the current year he has contributed a monograph "On the Syphilitic Diseases of Cerebral Arteries." Leipzig: Vogel.

Max Josef Oertel was born in Dillingen, in Bavaria, March 20th, 1835. From 1860 to 1863 he was Assistant at the clinic, in Munich, in the division of Dr. v. Pfeufer, who died in 1869. He passed the state examination in 1863. During his curriculum he worked out the prize questions in chemistry and physiology which were proposed by the Faculty in 1862 and 1863: "On the Abnormal Accumulation of Urinary Ingredients in the Blood and its Consequences" (his inaugural dissertation). During the same period, at the solicitation of Prof. Dr. v. Pettenkofer, he made a considerable series of analyses of the air in the various public institutions and localities, and private residences in Munich, the results of which appeared in 1863 in the "Münchener Gewerbeblatt" and the "Journal des polytechnischen Vereins," under the head of "Experiments on the Accumulation of Carbonic Acid in the Air of Inhabited Localities." After making the personal acquaintance of Prof. Czermak in the summer of 1861, he devoted himself arduously to the study of laryngoscopy and diseases of the larynx, in which he had the advantage of the abundant clinical material of Dr. von Pfeufer's division; in September, 1862, he performed (two months after Bruns' operation) the first extirpation of a laryngeal polypus by means of cauterization and crystals of chromic acid (Aerztliches Intellig. Blatt, 1868, No. 1, et seq.), by the endolaryngeal method. In December, 1863, he commenced the practice of his profession in Munich, and in 1867 established himself as Instructor in Internal Medicine at the "Ludwig-Maximilian University." The following articles were published during this period: "Observations in Laryngology" (Berl. klin. Wochenschrift, Bd. I.); "On Laryngeal Growths and their

Removal by the Endolaryngeal Method" (Aertzlich. Intellig. Blatt, 1868, No. 1, et seq.). The epidemic appearance of diphtheria in Munich during 1864 and the following years offered manifold opportunities for experimental and microscopical researches, which led to the discovery of vegetable organisms, micrococci, in the false membranes, mucous membranes, other tissues and blood of diphtheritic patients. He published a paper in 1868, in the Aerztl. Intellig. Blatt, No. 31, under the title, "Studies in Diphtheria," which was followed by a larger article in 1871, "Experimental Researches in Diphtheria," and a smaller article in 1874, "On Artificial Croup," in the Deutsch. Arch. f. klin. Medizin. In addition, a paper appeared in the "Zeitschrift für Heilkunde," on "The Extirpation of Laryngeal Neoplasms;" also in the "Journal für Kinderkrank.," the results of "Experimental Researches on the Action of Flowers of Sulphur in Diphtheria," and in the Aerztl. Intellig. Blatt for 1872, "Operation for the Removal of a Fibroid on the Vocal Cord."

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(Translated by Horatio Bridge, M.D.)

INTRODUCTION.

Henle, Pathologische Untersuchungen. Berlin, 1840. S. 1 ff.—The same, Handbuch der rationellen Pathologie. Bd. II. Abthlg. 2. Braunschweig, 1853. S. 457 ff.—*Griesinger*, Infectionskrankheiten. Virchow's Handbuch der spec. Pathologie und Therapie. Erlangen, 1857. 2 Aufl. 1864.—*A. Hirsch*, Handbuch der historisch-geographischen Pathologie. Bd. I. Abthlg. 1. Erlangen, 1859.—*H. Haeser*, Lehrbuch der Geschichte der Medicin und der epidemischen Krankheiten. Bd. II. 2. Aufl. Jena, 1865.—*J. F. C. Hecker*, Die grossen Volkskrankheiten des Mittelalters. Herausgegeben von A. Hirsch. Berlin, 1865. —*C. Liebermeister*, Ueber die Ursachen der Volkskrankheiten. Akad. Antrittsrede. Basel, 1865.—*A. Biermer*, Ueber die Ursachen der Volkskrankheiten. insbesondere der Cholera. Zürich, 1867.

UNDER the name *Infectious Diseases* we group together those affections which we know, or at least believe, must originate through the infection of the system with certain peculiar poisonous matters, and which are mainly distinguished from the ordinary poisons by the fact that they can reproduce themselves under favoring conditions to an endless degree. The classification of this group of diseases will, of course, be modified from time to time, according to whatever theory of their etiology is maintained; and yet it is easy to foresee that when investigations have been prosecuted further in this direction, infectious diseases will be found to occupy a far wider field than now is commonly given them.

If the poisons which produce infectious diseases can reproduce themselves and multiply, we can understand why these diseases do not occur in a sporadic form, limited to single cases, but that they are, for the most part, *diseases of the country* —*pandemic diseases* or *epidemics*—for when they appear in a place, they usually attack numerous individuals simultaneously or successively. They are *endemic*, when, as is the case with

malarious diseases, they are limited to a certain territorial district, and are domiciled there continuously, or, at any rate, for an indefinitely long time. They are *epidemic*, when they appear at intervals, and then again disappear, as is the case with the plague and the cholera.

As the majority of infectious diseases usually appear under an endemic or epidemic form, it is therefore quite fair to suppose that any disease, which we know arises endemically or epidemically, belongs to the class of infectious diseases. And so, in most cases, the names infectious diseases and diseases of the country convey to us the same meaning. There are, however, exceptions, from the very nature of the thing. It is not every infectious disease that appears endemically or epidemically under all circumstances. Syphilis, for instance, is extraordinarily common, and yet in our time it would be extremely surprising for any one to speak of its occurrence under these forms without committing a breach of the customary usages of speech. So too, again, it is not every endemic or epidemic disease that is necessarily an infectious disease; there can, for instance, be an ordinary poison that appears frequently in certain localities and occasions endemic intoxication; and it is also possible that certain conditions of the atmosphere, or other causes, may produce epidemic disease, in which infection plays no part at all.

As far back as history goes, we find records of devastating scourges. The history of diseases in a country forms an important part in the history of medicine; without it we find it impossible to understand the history of political science or of civilization. These great diseases have often destroyed the army of a conqueror; they have been the means of removing whole races of mankind from the earth; they have often given the death-blow to an advanced civilization, or have left a strange and enduring impress on the intellectual life of great nations. The most prominent students of these diseases have been right in assuming that among the causes which brought about the fall of the might and civilization of Greece and Rome must be mentioned destructive pestilences, chiefly those that swept over the eastern and western Roman empire during the period between

antiquity and the middle ages. It is generally known, too, how, in the fourteenth century, the most deadly of all the pestilences that are recorded in history, the Black Death, changed the direction of intellectual and social activity throughout the chief part of the civilized world, and showed its influence in the developments of the succeeding centuries. We can get but a faint idea to-day, through what we have seen about us, of the devastation that can be accomplished by epidemic diseases, and of the significance they have had in the whole rise of civilization. The epidemics of cholera, of typhus, of diphtheria, of small-pox, etc., which we have known, extensive as they have been, are utterly insignificant in comparison with the epidemics of earlier centuries. There is an instance of this in Basle, where two very severe epidemics have occurred within the past fifty years. One was a visitation of cholera in 1855, during which 205 persons died. The other was an epidemic of typhus fever, in the years 1865–6, in which, in respect to the number of people attacked and the malignity of the disease, there was no comparison with anything previously reported. Of a population of about 42,000, nearly 400 died of this malady. The mortality of epidemics in previous centuries was quite different. Felix Platter, in his Autobiography,[1] gives an account of seven pestilences of a deadly character which prevailed in Basle, and had been observed by him during his lifetime.[2] Every one of these epidemics (of the Plague) destroyed, proportionately, a much larger number of persons than the one preceding it. In the third epidemic, of the years 1563–4, the deaths were nearly 4,000, according to one computation, and, according to others, even as many as 7,000; in the seventh epidemic, of the years 1609–11, 4,049 persons died of the disease, according to an accurate estimate. The Black Death, which occurred about the middle of the fourteenth century, carried off 14,000 of the population in Basle. From Venice we learn that three-fourths of the inhabitants died of the disease, and that the remainder only escaped death by flying to the islands. Though the devastation in Germany was not so widespread as in the rest

[1] Published by Fechter. Basle, 1840. P. 192.

[2] "Siben regierende pestelentzen oder sterbendt ze Basel, die ich erlebt und darby gewesen."

of Europe, yet many more than a million lives fell a prey to the scourge, while it is said of Italy that she lost fully one-half of her inhabitants; and in England, according to statements, which may indeed have been overdrawn, scarcely one-tenth of the inhabitants were left. It is said that reliable statistics place the total loss of life from the Black Death, in all Europe, at from one-third to one-fourth the population; in Asia it is even likely, perhaps, that it was more considerable.

In looking for the causes that have operated to break the force of epidemics, we shall have, in the first place, to regard the advance of civilization and the improved sanitary conditions under which we live, as the most important of them; and, in the second place, too, our increasing knowledge of the nature of epidemic diseases and the way in which they are propagated. When, in fact, we see how little, during antiquity and the middle ages, medicine had realized its task of arresting pestilences, and how ill-qualified it was to accomplish it, we might rather wonder that a larger number did not die, and that still more of the culture of those days was not destroyed. If in later times we had been as heedless as formerly, it is certain that the Plague alone would have often carried off a large share of the human race from the earth. It was only the great difficulties and slowness of communication in those days that protected mankind from the still more frequent occurrence of similar misfortunes. These facts show the necessity of guarding against the extension of epidemic diseases by perfecting our means of protection; for just in proportion as the facilities of communication increase, so does the danger to society at large.

And now, at the present day, the mortality from infectious diseases forms an extraordinarily large portion of the total mortality. All the other mighty casualties of nature, such as earthquakes, volcanic eruptions, mountain avalanches, hurricanes, inundations by sea, have never, in the history of the world, even approximatively, destroyed as many human lives as a single ordinarily extensive epidemic. Even in war it is well known that the devastation, which has been produced by the scientific instruments of death, is usually not so great in extent as that which has been produced by the infectious diseases that have

broken out in the armies. Of all the great conflicts in modern times the war of 1870–1 is the first example of an exception to this rule; for the number of deaths from disease were far fewer than the number of deaths from external violence. This result may in part have been due to the obstinacy of the struggle and the great number of the fallen; perhaps, too, to the somewhat accidental absence of typhus fever and cholera; but it is also certain that it was due, in a great measure, to the advances which the science of Public Hygiene has made during our time.

Even the physicians of antiquity observed that in epidemic diseases the ordinary theories as to the origin of the disease were insufficient. They recognized that there was something extraordinary to deal with, and quite distinct from the ordinary phenomena. Thus they spoke of a *constitutio pestilens*,[1] and even up to our time it has been customary to speak of a diseased constitution, an endemic and epidemic constitution, a *genius epidemicus*. But as to the nature of this constitution of disease, or its real cause, there were usually very few clear ideas. The atmospheric conditions did not explain them; and so an especial influence of the sun or of the moon, of the planets and their constellations, the comets, or, at any rate, of the stars, was called to their aid, and what they could not understand was enveloped with astrological mystery. So earthquakes, volcanic eruptions, and inundations by sea, these "spasmodic convulsions of the sickened earth," were associated with the origin of epidemics, even if they appeared in totally different parts of the globe. They spoke also of a peculiar corruption of the air, which was often expressly declared to be thoroughly immaterial, dynamic. And all these, and many other ideas, some comprehensible and some not, were grouped under the name of "cosmo-tellurian influences." In later times they have had a particular preference for the influence of atmospherical electricity or ozone. At any rate, up to our time, the learned and unlearned have rivalled each other in the production of hypotheses, most of them not very poetic, but about as indefinite as the descriptions of old

[1] Κατάστασις λοιμική.

poets, who wrote of the death-bringing shafts of Apollo, or as the views advanced in a well-known modern novel, where cholera is associated with the footsteps of the "everlasting Jew." In almost all great epidemics, since the time of the Athenian plague, there has been a revival of the popular notion that the wells were poisoned. This idea had certainly the advantage over most of the hypotheses which were clothed in scientific guises, viz. : that it supposed a real cause.

Among the different hypotheses is one, perhaps the boldest and most remarkable of all, that has finally, after manifold mishaps, gained the preference over others. This is the hypothesis of a *contagium vivum seu animatum*, the theory that the poisons of infectious diseases consist of living beings or low organisms. Positive indications of such an idea are to be found among the writers of antiquity. The Roman authors of De re rustica, Varro and Columella, refer the origin of many malarial fevers to the entrance of low organisms into the body. And even before the discovery of Infusoria, the idea was frequently expressed that the plague of the day originated from minute organisms. This doctrine, however, obtained a wide recognition, when some sort of an actual basis for such theories was furnished by the microscopical demonstration of very minute living organisms, invisible to the naked eye. After the discovery of the Infusoria by Leeuwenhoek, followed, in the year 1677, his discovery of the Spermatozoa, which then, and even long after, were pretty generally taken for real animals. It having been thus proved, apparently, that there are living microscopic organisms within the living bodies of animals, and of man, the view that minute animals constituted the cause of epidemic disease was spread far and wide. To enumerate only the best known of the advocates of these theories, I mention the names of Athanasius Kircher, Lancisi, Vallisneri, Réaumur, Linné.

But even the most prominent representatives of the theory of a contagium vivum never reached anything more than rough conceptions, and many others lost themselves in the most remarkable extravagances. One writer of the seventeenth century proposed, in real earnest, that during the prevalence of epidemic diseases, the animals which were regarded as the cause of

it, and which, according to the common notion, were said to fly about in the air, something like a cloud of locusts, should be killed by making a great uproar with blowing of trumpets and firing of cannons. Others described the animals, which were supposed to have the form of moths, as armed with crooked bills and pointed claws. They distinguished the different kinds of animals which belonged to the various diseases; they gave them names, and even drew figures of them. It is readily conceivable that such fantastic ideas should bring down ridicule upon the whole theory.

In later times, the theory of a contagium vivum had been maintained, at first, it is true, with decided ill-luck. The statements of the first observers, who believed they had found the organisms that were at the basis of all epidemic diseases, were soon recognized as too hasty or overdrawn; the animalculæ of the small-pox, of cholera, the choleraic fungi, proved to be quite common infusorial organisms, such as can be found in all decomposing substances. And so it was rational that the earnest observer turned away with disgust from such phantasmagoria. About the middle of the present century, the judgment of condemnation which had been uttered over this theory was an almost unanimous one; it was regarded pretty generally as an unreal, unscientific play of fancy. Among the medical authorities, Henle was probably the last who elaborated the theory of a contagium vivum. This he did in 1853, with as much modesty as thoroughness, though even as early as 1840 he had maintained it with convincing logic.

Within the last ten years, however, a great revolution has taken place again with regard to the popular signification of a contagium vivum. New investigations on the appearance, mode of propagation, and the significance of the low organisms; new facts in regard to the extension of national diseases, and also a number of quite positive discoveries by numerous investigators, have removed the old opposition to the theory, or even been the means of furnishing definite proof of its correctness. The prophecy which I believed myself justified in making in 1865, viz.: that the theory of a contagium vivum would soon be the prevailing one, and that under its influence investigation would take

directions that would probably lead to results of the greatest theoretical and practical importance[1]—this prophecy has actually been fulfilled, in part, during the last few years. A great number of the best experimentalists are the declared adherents of the theory. At any rate, it is now admitted, even by those who do not unreservedly acknowledge the theory of a contagium vivum, that it represents a view "which points more clearly than any other to order in the chaos of facts."

It is true that the triumph of the theory of a contagium vivum is in no way complete; and as in former times, so now, it is not so much its opponents, as it is its imprudent adherents, who threaten to bring the theory into miscredit. The utter lack of critical discernment and method which have characterized some of the works in this field, and, on the other hand, the recklessness with which facts of uncertain significance have been proclaimed certain proofs, have also in our time driven away many an earnest investigator. But there is good ground for the hope that such extravagances will not permanently influence its recognition, and that methodical investigation will continue to gain a mastery over the question, and that the weight of undeniable facts, which are exposed to light in increasing numbers daily, will finally overcome every obstacle. We ought, if we desire to be just, not to refuse to recognize those observers whose conclusions we believe should be regarded with the greatest caution, for it was by the unwearied zeal and enthusiasm, with which they approached the subject, that they contributed so much towards bringing the ideas to maturity, and stimulated other observers to more exact investigations. The discussion on contagium and miasma vivum, perhaps the most important questions which have ever busied the medical world, will always continue to be in the order of the day, until they have been satisfactorily decided.

If we do not believe that the task of science is simply and solely to collect the greatest quantity of empirical material; but if, on the other hand, we think it justifiable and advantageous to try and establish a classification based upon theoretical

[1] Loc. cit., p. 23.

grounds—provided in searching for the relation of facts we do not recede from the deductions that come from them—we shall scarcely fail to allow that a long array of well-known facts furnish cogent reasons why we should accept either a contagium vivum, or, at any rate, a very similar hypothesis. It is very common indeed in scientific deductions to take no account whatever of the most ordinary and every-day occurrences, for the reason that we are so accustomed to them that they no longer appear strange or worthy of particular attention.

In the large majority of infectious diseases, the poisons by which they are called into activity have been hitherto unknown. We judge of their presence and their peculiarities only from their actions, and from the diseases which they produce. From the presence of these diseases, however, and the method by which they are propagated, we can also decide with positiveness upon the peculiarity of the poisons by which they are distinguished characteristically from all other poisons. *The poisons of infectious diseases can reproduce themselves, and to an unlimited extent.* With a minimal quantity of vaccine virus we can vaccinate a child, and obtain vaccine matter from him. From this child ten, and even more, children can be successfully vaccinated; from each one of these children ten more in turn, and so on; so that what at first was a scarcely appreciable quantity of the virus of the disease is sufficient to produce the disease in 1, 10, 100, 1,000, 10,000 children, and so on ad infinitum. There is no limit to the extension of the disease until there are no individuals left to whom the poison can be successfully conveyed; otherwise the number of persons who could be infected by a minimal quantity would be unlimited in the strict mathematical sense of the word.[1] As with the vaccine virus, so with variola, measles, scarlet fever, typhus fever, syphilis, malignant ulcers, blennorrhœas, etc., the poison can be multiplied to an endless extent. In opposition to such facts as these, all hypotheses which refer these poisons to certain known

[1] Since the results of experience in some cases seem to show that if vaccine be carried through a number of persons successively, the virus gradually, though very slowly, loses its force, the above statement is only strictly true when, after successive series of vaccinations, we return occasionally to the animal virus.

or unknown chemical combinations—and such views are even now sometimes advanced—must be abandoned as thoroughly untenable.

When we return to the question of the infinite capacity for propagation that is shown by the disease poisons, and when we ask what similarity there is between the characteristic peculiarities of these and other poisons, we are able to enumerate two distinct classes of diseased action ; and, in fact, from the time of antiquity these analogies have been repeatedly mentioned. The first kind embraces certain *chemical processes.* A burning shaving can set fire to a house and an entire city. The chemical process of burning multiplies itself ad infinitum, so long as combustible material and oxygen are present under favoring circumstances. "Ita ignis ignem generat, et maligno infectus morbo socium inficit." (Sydenham.) The second class embraces the *multiplication of living organisms.* Animals and plants multiply themselves ad infinitum, so long as there are suitable conditions for their existence. Accordingly, if we wish to seek for analogues to the poisons of the infectious diseases, we can only ascribe them to certain chemical processes, or to living organisms. It seems impossible, in accordance with the facts, to make a third class.

These two hypotheses, which alone explain the nature of infectious materials, have each found adherents.

Among chemical actions it is chiefly the processes of fermentation and decomposition, which by their capacity for extension, by means of the smallest possible quantity of matter, show the most striking analogy to the contagious diseases. The course of the manifestations, which are mostly violent, and many other peculiarities, still further carry out the analogy. The name *ferment*, or *zymotic diseases*, has found an extensive application to the infectious diseases.

The other hypothesis also possible is that of a *Contagium vivum.*

Since we know that those ferment processes, which here alone can be taken into consideration, and which we shall designate as fermentations, in the narrower sense of the word, are all associated with the presence and multiplication of low organisms, the theory of fermentation becomes virtually identical with

the theory of a contagium vivum. Accordingly, the existence of disease poisons, which have the capacity for infinite extension, necessarily gives rise to the theory of a contagium vivum; and this conclusion can only escape those who satisfy themselves with the simple facts, and do not care to build up any theoretical idea on the origin of the diseases in question.

Here the question may with propriety be introduced, how far we should consider the organisms, by which the diseases are produced, as distinct and independent; and it remains for us to present that idea of a contagium vivum, according to which it consists only of relatively independent formations of a cellular or celluloid character, belonging, it is true, to the diseased body, but capable of transmission and reproduction in other bodies with the maintenance of all their specific peculiarities. If such an idea is rather complicated and requires far more suppositions than the usual idea of a contagium vivum, it might still be applicable for several contagious diseases under our former beliefs. It is less acceptable, however, for those diseases whose contagium under certain circumstances has been known to remain outside the body without losing its capacity for life; and it is entirely untenable for those contagia whose reproduction is normally outside the body.

Finally, the question is also to be noted, how far the organisms, which act as disease poisons, exert their action in a more or less direct way, and how far they are related to the chemical products formed during their manifestation of life, or in consequence of their presence in the affected body. This somewhat subordinate question is to be especially taken into account for every single disease, and it will certainly find an easy solution with the widening scope of our knowledge.

Investigations into the organisms which lie at the root of all infectious diseases have scarcely been begun. The facts which have been proved without doubt will be alluded to in the description of the diseases as they occur, and it is not my intention to anticipate the particular and often variously conflicting views of the different collaborators. Still there are some diseases which may be noticed, in which I believe the more reliable proof is furnished that the organisms which appear in them are actually the sole and sufficient cause of the malady. As an example, I mention malignant pustule. The same view acquires a very strong degree of probability in the case of some other diseases, for, according to the facts hitherto observed, low organisms also occur in them; under this head are included pyæmia and puerperal fever. But even in these diseases our

knowledge of the nature of the organisms that lie at the root of the matter, and of their manner of action, is exceedingly deficient. It must also be confessed that in the very great majority of infectious diseases the proof of organized disease poisons has not yet been offered, so that the significance of the organisms sometimes found in them is quite doubtful. As an argument in favor of the view that infectious diseases are produced by low organisms, it will not be without significance to regard the facts which led in former times to the unexpected acceptance of parasitismus as the cause of disease. I only call attention to the numerous skin diseases produced by fungi, to the trichina disease, to the examples of mycosis intestinalis, which have been observed with increasing frequency in later times, as well as to the development of fungi in numerous other affections. Scabies, so long as the itch mite was unknown, was regarded as the prototype of a purely contagious disease, and even after the discovery of the mite there have been endless discussions, until finally this parasite, which is so easily detected, was recognized by all as the sole and satisfactory cause of the affection. The fact that this disease is now stricken out from the lists of contagious diseases, and reckoned among the parasitic, shows that we may perhaps expect further changes among infectious diseases.

In this connection, however, there are facts of considerable importance, which have been furnished by recent investigations into the nature of many contagious diseases in animals and plants. The contagious diseases of the silk-worm, which have been a source of so much danger to the silk-worm culture, have been proved to be parasitic, and the history of the development of the parasite has been followed pretty thoroughly. In flies and many other insects, we have known similar epidemics of a parasitic nature to have taken place.

The epidemic and contagious diseases of the higher classes of cultivated plants, such as the potato disease, the grape-vine disease, the ergot of grain, and others, all are derived from fungous growth. The question, too, on which for a long time opinions were divided, as to whether the fungus was the cause, or only the consequence of the disease, has been answered by the botanists with unanimity. Where the development of

the fungus had been thoroughly examined, they reported that it was the sole and sufficient cause of the disease. It is clearly evident, too, that the further the progress of investigation advances in human pathology, and the more frequently low organisms are shown in diseases, the more prominently will this question urge an answer. It is certain that the result will often show that the organisms discovered are only in a measure accidental occurrences, inasmuch as the products of certain diseases furnish a soil suitable for their development; gradually, however, the number of diseases will increase, in which some especial specific organism will be shown to be the only and sufficient cause.

It is evident, however, that before the organized disease germs can be regarded as among the well-authenticated facts for all, or even most of the infectious diseases, and before our more intimate acquaintance with the different excitants of disease shall furnish us better means for protection against, and cure of them, we have still in store for us a great expenditure of labor, time, and strength, as well as the need of favoring opportunities. Fortunately, the points of attack are sufficiently numerous, and a great number of zealous investigators have already undertaken the solution of these questions. However widely the observations, and especially the interpretations of them, may differ, yet all the work will, at last, unite to form a distinct whole.

Besides the capacity for propagation possessed by the disease germ, the infectious diseases exhibit still other peculiarities, which distinguish them from all other diseases; these peculiarities, too, are in great part of such a kind that they find their satisfactory explanation in the theory of a *contagium* or *miasma vivum*. The great scientific and practical value of this hypothesis consists in this, that it does not merely harmonize with the facts, out of which it was more or less directly evolved, but that it also furnishes a common standpoint from which to view numerous other phenomena, which otherwise would appear very remarkable, but which from this standpoint appear as necessary consequences. It must certainly be confessed that at the present

time there is a great difference of opinion with regard to the individual facts, for what one regards as determined the other doubts or questions. But even an hypothesis may be of advantage to the facts by bringing valuable criticism to bear upon them, and by showing not only how to formulate the questions, but also in which direction to push inquiries, in order that it may be possible to reach an accurate decision as to what is the truth.

A peculiarity of the infectious diseases, which they have in common with the poisons proper, or intoxications, but by which they also differ in the most marked manner from all other diseases, is their *specificness*, which shows itself in the fact that always, and under all circumstances, a given kind of disease is solely due to a given kind of morbid agent or cause.

There is no such constancy in the relations between cause and manifestations in other diseases. Exposure to the same degree of cold will occasion different affections, varying with the individuality of the person attacked: in one person a coryza, in another bronchial catarrh, in the third an attack of colic or diarrhœa, toothache, facial paralysis, or any other lighter or more severe "rheumatic" affection; or *vice versa*, a catarrh can originate from irritants affecting the mucous membrane of the nose, as irritating fumes, pungent snuff, mechanical injuries, or also from cold to which the feet have been exposed, or by poisoning, as, for instance, with iodine, or even by infection. On the other hand, vaccination with the virus of variola alone produces variola, if any disease at all is produced by it; vaccination with vaccine matter produces vaccinia only; infection from a patient with measles only produces measles, and never anything else. Infection with syphilitic poison produces only syphilis, and infection from a virulent blennorrhœa produces only a virulent blennorrhœa; and *vice versa*, whoever is affected with small-pox, measles, syphilis, etc., is certain that he has taken the disease by becoming infected with the poison of small-pox, measles, or syphilis, and of no other disease. Accordingly we see in infectious diseases the same completeness of the correlation between cause and manifestation as there is in the peculiar poisoning with chemical reagents. In infectious diseases, the predisposing

cause, which in most other diseases plays a more important part than the exciting cause, is to be considered only in so far as there may be a question as to the existence of a special susceptibility, and in so far as it may determine the severity of the disease; the kind of disease is entirely independent of it. Various physiological conditions, and, indeed, other pre-existing affections are influential only so far as they increase or diminish the susceptibility; the kind of disease will not be determined by it. Through the longest series of generations diseases preserve their specific character with the utmost persistency; and if, at times, some of these characteristics are not brought into complete maturity, owing to an unfavorable field for their development, yet they assume them again, so soon as they are planted in favorable soil. The weather, the period of the year, the climate, the condition of the soil, etc., conduce to or prevent the spread of an infectious disease, but they never change the nature of the disease; the diseases which appear in all climates, as cholera, small-pox, syphilis, exhibit the same essential characters everywhere. The kind of diet, and all other physico-chemical influences act indifferently with regard to the nature of the affection. In fine, it may be said that no individual or external influence ever decides the nature of the affection, and one infectious disease is never under such conditions changed into another.

The causes of infectious diseases are accordingly of a specific nature, and this characteristic is quite as pronounced as in plants and animals. As it is impossible for a donkey to be foaled by a horse, so is it just as impossible for a man to have scarlet fever or measles from infection with the poison of small-pox.

It is superfluous to show at any more length how this individual character of the causes which distinguish infectious diseases from all others, corresponds in the fullest manner to the view which bases these causes upon specifically different organisms. The doctrine of specificness would arise as a necessary consequence from the hypothesis of a contagium vivum, even if it were not already directly proved by the facts.

It is a theory, which is often brought forward under different guises, that under certain circumstances one disease can change itself into another, or that the kind of sickness, that appears in classes of the community, is solely dependent on individual

and external causes; at the same time it cannot be denied, that such a view would have special attractions for those who look at history from a remote point of view. And yet there is not a single certain and unequivocal fact, on which such a view could be based; at all events it must be confessed that none has yet been discovered since the time when investigations began to be made. But, while maintaining this, it is not necessary to assume an absolutely unchangeable character in disease. In the course of thousands of years it is possible that disease poisons may change their character just as animals and plants do.

From the specificness of infectious diseases we reach the natural conclusion that they never originate spontaneously, but are dependent upon a transmission, a continued propagation of the disease poison. This very conclusion, however, which has both a theoretical interest and also a far-reaching practical significance, is very far from being generally accepted, and perhaps the majority of physicians hold the view that certain infectious diseases can even in our day originate, so to speak, autochthonously.

Yet while we glance over the errors of later times, we can scarcely doubt that the doctrine of continuous propagation has a future for it, and that, at some time, not very far distant, it will be the generally accepted axiom for all infectious diseases. A few decennia ago it was shown, on grounds that were then unassailable, that the common parasites originated frequently, though not always, by equivocal generation. There was an *helminthiasis* of different varieties, a *phthiriasis*, and a *scabies*, diseases which were supposed first to appear autochthonously, and then, by equivocal generation, to produce the parasites associated with them; the latter being considered as something accidental, representing rather a symptom than the proper essence of disease.

How quickly and how completely has this view been changed into the opposite one! Belief in the equivocal generation of parasites, a law that forty years ago was recognized almost universally, has come to be generally regarded as an absurdity. The same gradual development of ideas, which in the case of the parasitic diseases finally reached a fixed condition of truth, has for a long time been taking place in an analogous manner in the case of the infectious diseases, and important advances have

already been made. Not a very long time ago it was almost universally accepted that merely the coincidence of certain especial conditions were necessary to cause the autochthonous appearance of a certain infectious disease. As early as the times of the Athenian plague, Diodorus found a sufficient explanation for the origin of the disease in the circumstance that a great multitude of people from all quarters streamed into the city, and, being cramped for room, breathed a corrupted air; "thus they were attacked with disease in an explicable manner." How many thousand times since then have medical and non-medical writers pictured social squalor, decomposing filth, unfavorable weather, etc., as the cause of disease! And physicians and laymen were accustomed to take it for granted that the Plague and similar severe epidemics originated after this fashion. Many physicians found no difficulty in explaining the origin of syphilis from the mingling and concentration of the immoral elements of numerous nations. The Plague arose from the imperfect burial of human corpses, with the consequent corruption of the air; yellow fever originated from foul bilge-water or from the crowding of men together in slave-ships; typhus fever from the crowding together of persons in badly ventilated dwellings, or from hunger; the cholera from rotten or unripe vegetable food; typhoid fever from the exhalations of putrid excrements, etc. For many it was an interesting spectacle to realize how the great regulatory operations of nature should be so simple and easily understood, and how every considerable deviation from a proper observation of hygienic laws should immediately be punished by the production of a particular disease. In recent times the standpoint has been essentially changed. The potency of these factors in the *extension* of the diseases in question is not questioned; on the contrary, our knowledge of it has become more reliable and exact. We have learned, however, that the diseases do not *originate* in this way. It was observed that the battle-fields of Inkermann, strewed with corpses, whose stench drove the armies away, produced no pestilence. We have been convinced that, in spite of the prophecies and premature reports, the investment of Metz was never able to produce a single case of typhus fever, inside or outside the city, or to transform ty-

phoid fever, which prevails there so frequently, to a possibly higher potence, *i. e.*, to typhus fever.[1] We have gradually reached the conclusion that it is only where the specific germ of the disease exists by itself, or has been introduced, that those anti-hygienic factors become active and may then be capable of occasioning an enormous extension of the disease. The germ, however, is not produced by spontaneous generation.

In fact, at the present time, the acceptance of an autochthonous origin for syphilis is, for most physicians, as great an absurdity even as the origin of scabies or of lumbricoid worms by spontaneous generation. It is unanimously said of the plague, cholera, and yellow fever, that they never arise spontaneously, at least on European soil. The spontaneous origin of small-pox, measles and scarlet fever could scarcely find a defender now. Perhaps the time is not far distant when the doctrine of the spontaneous origin of typhoid fever, dysentery, typhus fever, etc., will be universally rejected.

In adopting the theory of the continuous propagation of the poisons of infectious diseases, we need not exclude the possibility that infectious diseases, which have never existed before, may appear in our midst, or that perhaps others, which for years or centuries have utterly disappeared, may again come to light. It is supposable that there exist certain low organisms, which usually vegetate and propagate themselves outside the human system, in the decomposition of organic matters, or in plants and animals, but which under special conditions become implanted in man, find there a favorable soil for their development, and may then represent the specific cause of an infectious disease, which for a long time has been transmitted from man to man. At any rate, nothing can be urged, theoretically, against such a possibility; and that something similar actually occurs is shown by the transmission of the infectious diseases of the higher animals to man. Besides, such occurrences have often been supposed, though it is true they have never yet been proved.

One of the most remarkable peculiarities belonging to many, but not to all infectious diseases, consists in the fact that a

[1] Niemeyer, who thought it possible that typhus fever might originate spontaneously, or be developed out of a typhoid, and believed that under the circumstances referred to above it was to be feared, made personal and critical observations among the besiegers and besieged, and satisfied himself that typhus fever did not exist there at all.

single attack of the disease, successfully surmounted, bestows an absolute or relative *immunity* from it for a certain time, or even for the remainder of life. This fact is especially true in measles, scarlet fever, variola, vaccinia, typhus, or yellow fever. In two of these diseases, viz., in variola and vaccinia—which are specifically different from one another, and of which one never changes into the other, but which, as different varieties of the same species, show indeed many points of similarity—the relation is such that one disease, successfully overcome, is a protection against the other. The question as to the cause of this immunity has not, thus far, been answered with definiteness. The theory of a contagium vivum affords us certainly the best means of explaining such remarkable facts. We have here to do with a ferment process, such as was repeatedly alluded to in the first half of this century. If yeast be placed in a fluid containing sugar, fermentation takes place; but when all the sugar has been destroyed, and fermentation is complete, it cannot be produced again by a further addition of sugar; the fluid responds no longer to the action of the yeast. It is supposable, that in the diseases which only attack man once, something analogous takes place; perhaps during the disease there is a destruction or change in the body of some of its chemical or morphological constituents, whose presence is a necessary condition for the retention or development of the disease poison.

The *division* and *classification* of infectious diseases can be made according to various views.

We can, in general, distinguish, in the development of the science of pathology, three such views, according to which opinions were formed as to the similarity or dissimilarity of cases of sickness, or upon which the unities of the disease were based. At first the basis was a purely *symptomatic* one; they grouped the cases together as the same, or similar, if the symptoms were the same or similar. Thus originated the old unities of disease, as, for example, Hydrops, Icterus, Apoplexy, Phrenitis (Delirium of fever), Kausos (Febris ardens), etc. From this symptomatic standpoint, quotidian fever was a different disease from

the tertian or quartan form. On the other hand, ascites and tympanites were only different forms of the same disease. The consistent advocates of this view expressly discarded all reference to pathological anatomy or etiology. If, for example, a patient was thought to have a hepatitis, chiefly from the seat and kind of pain, and afterwards, at the autopsy, there was found to be a pleurisy of the right side, while the liver was sound, the diagnosis was not in the least damaged by it; it was rather a confirmation of the idea that the nature of a "disease" should not be based upon the anatomical seat, but rather upon the symptoms.[1]

With the progress of anatomical investigations the conclusion became more and more evident, that a symptomatic classification was unscientific, because it regarded unessential similarities and differences as more important than the real *materies morbi.* Gradually there came to be a classification on the basis of pathological anatomy, as well as symptomatology, and finally the former attained the undisputed mastery. The great advances which pathology and diagnosis have made in the present century are attributable mainly to the carrying out of this principle. It is true that a narrow application of this principle has led to many errors. When it was desirable to localize all diseases, a great number of infectious diseases were classed as gastro-enteritic. Intermittent fever was a splenitis, the acute exanthemata were inflammations of the skin; and phthisis, puerperal fever, etc., they attempted to analyze into anatomical unities.

This principle of pathological anatomy is not, however, the final one which science has to accept; and even in our day she is on the point of exchanging her present one for another, without yielding up the knowledge which it has furnished, and promises still to furnish. As in all experimental science, so also in pathology, the conviction is growing stronger that in the investigation of diseases, at all events, the idea of causality represents the last point to be reached, and accordingly the most scientific rule of classification must refer to causes, *i.e.*, must

[1] Compare *Sauvages*, Nosologia Methodica. T. I. Amstelod., 1768. P. 501.

be *etiological.* Already this ground has shown itself to be extraordinarily fertile, and the future has a still greater yield in store for it. During the rule of pathological anatomy, while pathology and diagnosis were making rapid progress, and while proper recognition was made of all they accomplished, the reproach was often expressed, and with reason too, that the practical goal of all medical science, therapy, gained no direct advantage from the new discoveries, but, on the contrary, that it was rather pressed into the background. Now, if the etiological principle is carried out upon the ground prepared by the anatomical discoveries, it promises to do as much, or even more, for therapy. We shall always be learning more and more how to grasp the trouble at its root. The *indicatio causalis* will again assume a higher position in therapeutics, and we shall find more efficient remedies with which to answer it. And finally, in many diseases, we shall have a successful prophylaxis which may make therapeutics, in the narrower sense of the word, superfluous,—a thing which could scarcely be hoped for under the older ideas. The science of public hygiene, which has already made such extraordinary advances in its still very obscure beginnings, is an outgrowth of the etiological principle, and is so firmly rooted in it, that the two cannot be disconnected.

We are certainly far from having a complete etiological classification, because our knowledge of the causes of disease, which have only very lately been subjected to a systematic investigation, is still confined to the first rudiments. The unities of disease are still mostly anatomical; indeed, in many departments, we have not even reached this point, but are still obliged to recognize symptomatic unities. We still have such diseases as diabetes, neuralgia, epilepsy, mental diseases, etc.

The most advanced position reached thus far is the one now held with regard to the etiology of infectious diseases. This group rests upon an etiological basis, and there is scarcely any difference of opinion respecting its value as the best ultimate foundation for classification in these diseases. We regard the quotidian and the quartan fevers as, in the main, the same diseases, so far as both have been shown to originate from malaria;

we differentiate them from the pyæmic febrile attacks, although they may perchance have a similar rhythm and similar symptoms; we include among them, however, other malarial affections, which differ greatly in symptoms, such as malarial neuralgia, malarial diarrhœa, malarial cachexia, etc. The lightest form of varioloid is regarded as essentially identical with the most severe form of variola; on the other hand, vaccinia and varicella are separated from them.[1] In making a differential diagnosis, therefore, we are not to rely upon the similarities or the differences in symptoms or pathological anatomy, but simply to consider the circumstances that serve to settle the question, viz., which of the various specific disease poisons has been the excitant of the attack, and what disease can eventually be transmitted by it. The simplest diarrhœa, arising from the poison of Asiatic cholera, is theoretically to be ascribed to this disease; on the other hand, a very severe, and even deadly cholera morbus is to be marked as another disease. In the contest on the relation of a soft chancre to syphilis, or of croup to diphtheria, the question is no longer as to the proof of similarities or differences in the symptoms or local lesions, but chiefly as to whether both are produced by the same or different poisons. Perhaps the time is not far distant when the difficulties and contradictions, which at present the doctrine of phthisis offers, will simply be solved by disregarding the local lesions, which are sometimes accidental, and allowing etiology to decide the question of identity or difference. Certainly the doctrine of pyæmia and even of puerperal fever will never be clearly understood until we resolve to give up our anatomical guarantee and take up the etiological.

To understand the pathology of to-day it is absolutely necessary to keep in mind the changes in the dominant ideas as they have taken place from time to time. Among other things it is important to remember that even in those departments, where the classification is now generally based upon the etiological system, the nomenclature is still in great measure the same as that used in the time of symptomatic pathology. If it

[1] Translator's Note.—By Hebra and others, varicella and variola are regarded as identical.

had been possible to introduce new names for diseases, to conform to the change in the system, much confusion and much unnecessary conflict would have been avoided. If this had been done, there would no longer be any physicians who believe that because two different diseases are still accidentally called typhus,[1] it is a reason for regarding them as identical, or, at any rate, as nearly related.

It is well known that, during the last century, and in the first third of the present one, extraordinary efforts were made to found a most complete system for the classification of diseases. They endeavored, as Boissier de Sauvages expresses it, on the title-page of his Nosologia Methodica, to make "*morborum classes juxta Botanicorum ordinem*," and divide the classes into natural orders, families, and species. For a long time the best intellects have been similarly busied, and a natural system of diseases was for a long time thought more desirable than a more intimate acquaintance with the diseases themselves. In recent times, and under the influence of the anatomical rule, all such efforts have been given up as irrational and utterly fruitless; it was found impossible to accomplish the object in view, since the idea of species, which lies at the basis of all the classifications of natural history, is not applicable to diseases which only represent processes and not individuals. We go, however, too far, in rejecting all these tendencies, and particularly so in the case of the infectious diseases. As specific causes lie at the root of these, so they have a right to the same sort of classification as would be proper in zoology and botany,—one too which would be in full accordance with the modern etiological basis of pathology. For example, the acute exanthematous diseases could form a natural order or family, in which one of the species would embrace the varioloid exanthemata, and as varieties might include variola, vaccinia, and perhaps also varicella.

For the present the inauguration of such a system is not to be thought of; it would only be possible after the different disease poisons have been satisfactorily investigated. Thus far we are almost entirely ignorant of them, and of their natural simi-

[1] TRANSLATOR'S NOTE.—The Germans recognize two forms of typhus fever—one, exanthematous typhus, our typhus fever; and the other, abdominal typhus, our typhoid fever

larities and differences, and we can only draw conclusions or suppositions from their manifestations, and from the appearances and course of these diseases. We do not need, however, to renounce every system, and, if our classifications still fall short of the ideal of a rigid system of natural history, they are nevertheless not without value, for they, at least, serve to show clearly the similarities and differences between various diseases. The plans upon which we may classify are very numerous, and we should fail to recognize the present condition of progress, and the aim of such a classification, were we to give one plan unconditionally a preference over all others. We are willing, in general, to give higher scientific dignity to any basis of classification, in proportion as it attaches weight to some essential peculiarity in the excitant of disease; but it will often happen that the immediate object in view will require preference to be given to a nomenclature that has a less scientific value.

In the first place, we can distinguish between *acute and chronic infectious diseases.* To the acute belong the greater number, and of these the majority have a typical course, and last for definite periods of time. Usually we may distinguish a stage of incubation, which embraces the interval from the reception of the poison within the body until the appearance of the first manifestations of disease; then a prodromic stage, which continues from the appearance of these first manifestations to the appearance of the characteristic manifestations of the disease in question; and then, finally, the subsequent course can be divided into a variety of imperfectly defined stages, depending upon the development of the phenomena and the changes in the pathological anatomy of various regions. We are justified in supposing that these separate stages correspond with certain phases in the evolution of the morbid agent.—Among the chronic infectious diseases, to which belong chiefly the malarial diseases, the virulent blennorrhœas, the simple virulent ulcers, and syphilis—but among which, in future, phthisis will also be included—there are some that in the commencement certainly show a typical course, a more or less constant succession of symptoms and of anatomical changes; in duration, however, they have no definite limits.

The distinction between *volatile* and *fixed* disease poisons lies in the fact that some of them can be conveyed to the human body by means of the air, while in others such a transmission does not seem to take place. The cause of malarial diseases is in this sense volatile, and so is the poison of typhus fever and many other diseases; while the contagium of syphilis is fixed, as is also the case of the virulent ulcers and blennorrhœas, of rabies, etc. It is hardly necessary to say, that the expression volatile is not to be taken in the sense of the chemists, for no one of these disease poisons can really be gaseous; they can, however, be suspended as free bodies in the atmosphere, be inhaled with the breath, or deposited on the surface of the body.

More important and more in accordance with the nature of the exciting morbid agents is the division of infectious diseases into *miasmatic* and *contagious*. *Miasm*, in the original and broadest sense, is the name for any material contained in the air, that can produce disease. The old writers frequently used the term in this broader sense, when they spoke of the miasm of measles and small-pox, but they also included with it, the non-specific noxious matters mingled in the air, as for example, the products of putrefaction and decomposition, and sometimes even all kinds of injurious gases. Later, the term miasm, being brought into contradistinction with the term contagium, was used in a far narrower sense, and in this narrower sense it is now solely used.

It is usual now to speak of *contagium* as a specific excitant of disease, which originates in the organism suffering from the specific disease; while *miasm*, on the other hand, is used of a specific excitant of disease, which propagates itself outside of, and disconnected from, a previously diseased organism. Contagion can be conveyed by contact, from a diseased person to a sound one, produce the disease in him, and then again reproduce itself. Miasm originates from without; taken up into the body, it can call a specific disease into action; but it cannot spread the disease any further by conveying it from a diseased to a sound person.

Lately the idea has been advanced by many that these old ideas are superannuated, that they must be given up entirely, or that at least quite another signifi-

cance must be given them than before. Now, it must be acknowledged that it is impossible to classify all cases that occur, without further ado, according to these two categories; nevertheless these ideas, interpreted in the sense that has hitherto generally been accorded to them, are now also quite appropriate and useful; the difficulties, which were so frequently met with in the use of them, were not so much dependent on a faulty definition of the ideas as on an imperfect appreciation of the cases to which they were applicable.

There are diseases which are purely contagious, and diseases which are purely miasmatic.

Measles, scarlet fever, variola, vaccinia, typhus, diphtheria, glanders, malignant pustule, rabies, virulent ulcers and blennorrhœas, syphilis, pyœmia, and puerperal fever are purely contagious. In all these diseases the poison can be conveyed from one individual to another by contact; but it is true that direct contact is not a necessary condition for the transmission; it can also follow *mediately* from the vaccinator's lancet, from other instruments, from clothing, through third persons, and in many of these diseases by the air. Under favoring circumstances, many contagions can retain their vitality and power of infection for a long time, outside of the organism which produced them. But under all circumstances,—and this necessarily belongs to the idea of a purely contagious disease—the poison has no special stage of development to pass through on the way from the infecting organism to the one to be affected; but at the time of infection it is essentially in the same condition as when given up by the organism yielding it.

The malarial diseases are purely miasmatic. In them the morbid poison develops itself externally; its reception into a higher organism is not necessary for its reproduction, and therefore is something accidental for the life of the morbid poison; within the body it appears to vegetate for an indefinite time, and, indeed, so far as we can conclude from the symptoms, with phases of development that follow one another in rhythm. Thus far it has not been known that the germs, reproduced within the human system, can be conveyed to other men, and can infect them, or that they can again escape from the body and reproduce themselves further; therefore, we must define malarial diseases as purely miasmatic, in the sense of the definition.

And so, according to the extent of our present acquaintance with the mode in which diseases are propagated, we may easily class any of the diseases, that have been described, either under the head of contagious or under that of miasmatic diseases. It is probable that a more intimate knowledge of the morbid agents in contagious diseases will bring to light many and perhaps profounder differences, that may call for still further divisions; but it does not appear very probable that, in the future, we shall be obliged to make any essential change in the general definition.

But, besides the diseases that we have mentioned, and some others, whose mode of extension has remained in total obscurity, there are still other infectious diseases whose mode of extension we understand sufficiently well to be able to state with certainty that they can neither be reckoned among the miasmatic nor among the contagious diseases, in the sense of our definition. Chief among these are *cholera*, *typhoid fever*, *dysentery*, and probably, also, *yellow fever* and the *plague*.

Let us take cholera as an example, and examine only the most general questions. There is no disease, perhaps, if we except only vaccinia, upon which so much has been written as upon cholera, which has only been known in Europe for a few decennia; and yet opinions as to the first and most important question—whether it is contagious or not—are not yet in full agreement. Both the opponents and the advocates of its contagiousness appeal to facts that apparently should be sufficient to place the solution of the question beyond doubt.

In the first place, it is not to be denied that cholera is seldom conveyed directly from person to person. Physicians and nurses of cholera patients are not much oftener attacked by the disease than other persons. Inoculation with the blood, the secretions, and the excretions have yielded negative results. A French physician in Warsaw, who allowed himself to be carried away by scientific zeal so far as to swallow matters that had been vomited by cholera patients, did not die of cholera. On the other hand, innumerable men are attacked by cholera without having touched or even seen a cholera patient. From these facts numerous observers have drawn the conclusion that cholera is in no way a contagious disease.

Opposed to this, however, it is quite as firmly settled that cholera never appears in a locality without being transported into it from an already infected locality. The truth of this statement can be proved in any local epidemic that is accurately observed. In fact, the number of exact observations confirming it is already enormous, though in some epidemics, as in some cases of disease, it is natural that the transportation should not have been proved. So in each epidemic, or in each single case of variola, we cannot show how infection takes place; but there is scarcely a physician, in our day, who entertains any serious thought about an autochthonous origin of the disease; his doubts refer simply to the incomplete establishment of the facts. Among the vast amount of data, which show that cholera only originates in places where it has been brought by traffic, there are two facts which have frequently been instanced, and which contribute greatly to prove it. At the time of the first cholera epidemic, it never happened in a single instance that cholera was more rapidly conveyed from one locality to another than a man could travel by the ordinary methods of conveyance. In traversing the distance from Astrachan to Paris,—which it did, it is true, with many deviations and temporary halts—it occupied the time from August, 1830, to March, 1832. Why, if the disease could be propagated independently of the lines of travel, did it advance so rigidly step by step? That this slow progress does not depend at all on other peculiarities, but, in reality, only on the slowness of travel, has been most distinctly shown in later times. Now cholera travels with our most rapid means of transportation. In traversing the distance from Alexandria to Ancona, in the year 1865, it only employed as much time as the steamer which carried the passengers; in 1867 it spread from Rome to Zurich in four days; under certain circumstances it could be carried now from St. Petersburg to Paris with the rapidity of a railroad train. The second convincing fact is, that the march of the epidemic always follows lines of travel. The direction of the wind, the course of the stream in the great rivers, is immaterial; cholera progresses both with and against the stream, if only travel is in both directions. In America and in other countries separated by the sea from the

infected parts, cholera has never made its first appearance in the interior of the country, but always in the ports, at which ships have arrived from infected districts. These facts have led the majority of physicians to consider the cholera as an exquisitely contagious disease.

In fact, we must recognize it as a settled fact, in the first place, that cholera is not transmitted from person to person; and again, too, that it never originates spontaneously, as from a spontaneously produced miasm, but that affected persons have always been the medium through which the disease made its appearance.

Quite analogous conditions occur in other infectious diseases, which are neither to be enrolled in the list of miasmatic nor in that of contagious diseases, as for instance in typhoid fever, dysentery, and probably also in yellow fever and the plague.

Now, how can the two opposing facts be assimilated, that these diseases are not transmitted from person to person, and yet can only be occasioned in healthy individuals through the medium of infected ones? Supposing our hypothesis of the nature of infectious diseases to be correct, the apparent contradictions will almost be explained. The tape-worm even cannot be transmitted directly from one person to another; and yet it is well known that it only appears under this form after it has passed through a certain stage of development. If we think that a procedure, similar to what we know with sufficient accuracy takes place in the development of the tænia, also takes place in the development of every disease poison: that, for example, the organisms which are at the root of cholera have, in their reproduction, to pass through two stages of development, the one outside the human body, and the other within; then the difficulty which envelops the affair is removed. The fresh discharges of cholera patients contain these organisms in the stage of their development in which, if introduced into the body of another, they do not reproduce themselves further, and can cause no infection with cholera; before they are again capable of it, they must pass through another stage of development outside the body. This occurs, when the discharges remain some time standing, but particularly when they come in contact with

great quantities of organic substances that readily decompose, as in water-closets, dung heaps, sewers, or, too, in the soil of inhabited localities that are damp and rich in organic débris. In this stage of development there seems to be a considerable increase of the poison, and after this reproduction it is again in a condition to multiply further in the human body and produce the disease.

Since, therefore, cholera, typhoid fever, dysentery, etc., cannot be conveyed from diseased to healthy individuals by mere contact, they are not contagious according to the significance of the term. They have this in common with the miasmatic diseases, that the poison is first of all drawn from without; but they also differ from them in the fact that the poison only originates outside the body when an affected body has furnished the germs. It is quite proper, therefore, to form a third group, and give these diseases the name of *miasmatic contagious diseases*, which they have held for a long time, though, it is true, usually in another sense.

The necessity of supposing at least two stages of development, which shall alternate with one another, and must be passed through, in the process of reproduction, does not belong only to the miasmatic contagious diseases. A similar supposition, though in a somewhat modified form, must also be made for many diseases that are contagious in the narrow sense: such, for example, as have a sharply defined period of incubation. If a man is infected by the absorption of the contagium of small-pox, measles, and scarlet fever, the manifestations of the disease do not commence at once, as the case would be after taking a chemical poison; on the contrary, the infected person is at first entirely healthy, and only after a definite period, which is different for each of the above-mentioned diseases, do the first manifestations appear. What notion, then, must we have of the process that is going on in this disease poison during the time of incubation? One might, at first, suppose that the quantity of poison received was too small to produce of itself violent symptoms, and that therefore there must have been a progressive increase of the poison within the body before the manifestation could assume a distinct appearance. Such a view, however, though often made to explain the remarkable fact of incubation, does not correspond with experience. Whether a man introduces into his blood little or much small-pox virus, whether a man has been vaccinated at one or at ten points, the period of incubation is the same. Besides, the manifestations do not develop themselves slowly and with constant increase from the moment of infection, as the case would be by a gradual multiplication of the poison and, consequently, gradually increased action; on the contrary the

proper period of incubation is entirely free of disease manifestations; the outbreak occurs suddenly, and only after the lapse of a certain number of days. There remains, apparently, no other way of explaining the fact of incubation than to adopt the theory that the poison, after its entrance into the organism, has to pass through a particular stage of development, which lasts for a certain period of time, and is accompanied by an increase of the poison. Accordingly, both in the purely contagious diseases with a period of incubation, as well as in the miasmatic contagious ones, we are forced to accept the theory of different stages of development, alternating with one another; in the miasmatic contagious diseases, this stage must necessarily occur outside the body; in the purely contagious ones, all the stages take place within the body. As the transmission of miasmatic contagious diseases may be compared with the transmission of the tape-worm, so the transmission of the purely contagious diseases bears a resemblance to the transmission of trichinæ.

Finally, there is another difference of great practical significance, according to which the infectious diseases may be divided, and which consists in the fact that some of these diseases from their commencement are limited to a relatively small surface of the body, and remain so, while others, immediately after the first appearance of the characteristic manifestations, show themselves as disturbances which are distributed over the entire body, or, at least, over a great part of it. The first may be classed as *local*, the latter as *general* or *constitutional infectious diseases*. Examples of local infectious diseases are virulent blennorrhœas, to which, besides the ordinary gonorrhœa and the specific blennorrhœas of the eye, whooping-cough is also to be reckoned, as also the simple soft chancre. The specific blennorrhœa of the urethra can extend farther along the mucous membrane and affect the bladder, the prostate, the vas deferens, the epididymis, etc.; and the chancre, by repeated inoculation, can be transferred to numerous other parts of the surface, or to the nearest lymphatic glands, and so produce purulent buboes; the disease, however, always remains local, and the greater number of diseased foci does not change essentially their local character. Even in gonorrhœal metastasis, the question is not so much of the general infection of the disease, as of the appearance of a new local affection at a more distant point, although here the mechanism of transmission has thus far been obscure. On the other hand, in contrast with the local affection, there is syphilis, which is a general disease. At the time when the first local appearance

takes place, the syphilitic poison has already been widely disseminated through a great part or the whole of the body. Even the acute exanthemata, the small-pox, scarlet fever and measles, are now usually not regarded as skin diseases, but as general maladies. The skin implication in them is only the expression of the general disease, and not the first; for long before the appearance of the exanthem there are general disturbances, such as fever. The local diseased processes, which appear as expressions of a general disease, are usually designated as *localizations* of the general disease.

We frequently meet with the statement, that a disease is general or constitutional, and that the purely local affections should not be classed among the infectious diseases,—as if this very term excluded such an idea. But there is nothing in the name of infectious diseases that should lead to such a conclusion; on the contrary, in the local diseases mentioned above, the fact of an infection is as plain as in almost any other disease. And besides, these diseases that are transitional between the local and the general, or in which it is doubtful to which category they belong, teach us that such separation would not be proper.

There are only a certain number of the infectious diseases of which we have thus far been able to say with certainty that they belong to the general or local diseases; in regard to others we can only have more or less definite hypotheses, and an absolute decision can only be reached when the individual disease poisons are better known and have been more carefully studied in their relations to the whole body. Among the general infectious diseases we can safely count, besides syphilis and the acute exanthemata, typhus fever, the plague, typhoid fever and the malarial fevers—the latter at least at the onset of the attack. On the other hand, dysentery is just as certainly to be classed among the local infectious diseases, since in it the diphtheria of the large intestine is the sufficient cause of the general disturbances, complications, metastases, etc. As for cholera, in which the relations are much more difficult to estimate, it is well known that Niemeyer[1] has maintained a similar view, and I think successfully, for he has shown that the manifestations of cholera can be distinctly traced from the intestinal affection.

[1] Lehrbuch. Band II.

and there is no need of assuming that the poison acts directly on the blood, the heart, or the nervous system. The same author[1] has further shown, for *meningitis cerebrospinalis epidemica*, that all the phenomena can be referred to the affection of cerebral and spinal membranes, so that this disease belongs also to the local affections; and from what has been said above it is clear that we should not separate them from the infectious diseases. Finally, I have attempted, in the case of yellow fever, to furnish proof that the manifestations of the disease may be referred to a parenchymatous hepatitis that is due to specific infection.[2]

Some other diseases cannot be formulated under any one of these two groups. In diphtheria the early phenomena are doubtless of a purely local nature; but in their later course the poison can be taken up into the circulation, and be so completely disseminated through the entire body that the disease may in this way become a general affection. A similar view might perhaps be adopted for pyæmia and puerperal fever.

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[1] Die epidemische Cerebro-Spinal Meningitis nach Beobachtungen im Grossherzogthum Baden. Berlin, 1865.

[2] Beiträge zur pathologischen Anatomie und Klinik der Leberkrankheiten. Tübingen, 1864. P. 261, et seq.

TYPHOID FEVER.

LIEBERMEISTER.

TYPHOID FEVER.

P. Ch. A. Louis, Recherches . . . sur la maladie connue sous les noms de gastro-entérite, fièvre putride, adynamique, typhoïde, etc. Paris, 1829.—*W. Jenner*, On the Identity or Non-Identity of the Specific Cause of Typhoid, Typhus, and Relapsing Fever. Medico-Chirurgical Transactions. Vol. XXXIII. 1850, p. 23.—Lectures on the Acute Specific Diseases. Medical Times and Gazette. 1853. March 5.—*Wunderlich*, Handbuch der Pathologie und Therapie. Bd. IV. 2 Aufl. Stuttgart, 1856.—*A. Vogel*, Klinische Untersuchungen über den Typhus. 2 Aufl. Erlangen, 1860.—*Griesinger*, Infectionskrankheiten. 1 Aufl. S. 118 ff. 2 Aufl. S. 145 ff.—*Hirsch*, Historisch-geographische Pathologie. S. 158 ff.—*Ch. Murchison*, a Treatise on the Continued Fevers of Great Britain. London, 1862, p. 385, sq.—*F. Niemeyer*, Lehrbuch der spec. Pathologie und Therapie. Bd. II.—*A. Trousseau*, Clinique médicale de l'Hôtel-Dieu de Paris. Tome I. 2 édit. Paris, 1865, p. 212.

The expression Typhus (*Τῦφος*) signified originally smoke, vapor, and was afterwards used to denote an overclouding of the senses. The name was principally applied to cases of disease, in which the prostration of the mental faculties constituted a prominent symptom. The name typhus, however, never came into general use among the ancient physicians,[1] although we find in the Hippocratic writings[2] a number of different conditions described under this appellation. The Greek and Roman physicians did not recognize as distinct diseases the affections which are now called typhus. We can, indeed, hardly be certain, from the meagre descriptions of these authors, that this disease was really known to them. But their writings certainly give the impression that many of the cases, which they called phrenitis, lethargus, koma, kausos, synochus, pestis, febris putrida, etc., really belonged to this disease.

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[1] It is more frequent to find, as in Galen, the expression Typhomania, to designate a semi-comatose condition complicated with delirium.

[2] De internis affectionibus. *Ed. Kühn*, II., p. 496.

Boissier de Sauvages[1] introduced into pathology the word typhus to denote a group of diseases. This group he subdivided into typhus carcerum, nervosus, comatosus, castrensis, icterodes (yellow fever), etc. He even described a typhus hysterico-verminosus, a typhus exhaustorum, a typhus produced by poisoning with cassava juice. In the same way the name typhus came gradually into general use to denote merely certain symptoms, and was applied at first to all diseases in which there was a well-marked typhoid condition; whether this condition occurred in what we now call typhus, or in pneumonia, variola, scarlet fever, pyæmia, puerperal fever, uræmia, etc. Others, however, confined the name to the affections, which had been previously known under the names of febris nervosa, maligna, continua putrida, ardens, pestilens, bellica, castrensis, petechialis, etc. Those lighter cases of real typhus, in which the peculiar typhoid symptoms are wanting, were called by other names: febris simplex, gastrica, mucosa, biliosa, continua non putrida, etc.

When more attention was given to the morbid anatomy of disease, the attempt was made to introduce an anatomical definition for typhus. It was found, especially in France, since the beginning of the present century, that in numerous single cases, with all the symptoms of typhus, a characteristic lesion in the ileum and mesenteric glands was present. Moreover, there were epidemics of typhus in which all the fatal cases exhibited these lesions. For this reason the conclusion seemed to be warranted that these lesions were really characteristic of typhus, and that the disease was really a local affection of the intestines, a gastro-enteritis, enteritis follicularis, dothienenteritis, furunculosis of the intestinal mucous membrane, an enanthema in contrast to the acute exanthemata. On the other hand, cases were observed in which the symptoms resembled those of typhus, while the intestinal lesions were absent. This was especially the case in England, where some epidemics of typhus were entirely without the intestinal lesions, while in other epidemics both cases of typhus with intestinal lesions and cases without such lesions

[1] Nosologica methodica, T. I. Amstelod., 1768, p. 308.

occurred. The English and French observers were reluctantly compelled to admit that the cases seen by them must belong to different categories. It was found, also, that a strict adherence to the anatomical classification would render necessary a still further division of the disease.

In this way observers began to speak of different varieties of typhus, according to the particular morbid anatomy of each case. They even considered the lesions which belonged to the complications and sequelæ of typhus as varieties of that disease. So they described abdominal typhus, cerebral typhus, pneumonia typhus, laryngo-typhus, exanthematous typhus, etc. Some observers considered these different varieties, to be really distinct diseases, but the more general belief was that they were only different forms of the same disease.

When the principle of classifying infectious diseases according to their etiology, was gradually introduced, another change of opinions followed. To decide as to the identity of the different forms of typhus, neither the symptoms nor the lesions were any longer considered to be sufficient guides. The etiology was looked on as the only criterion, and everything else was only regarded in its bearing on this point. The question was now propounded in this way : Is there one poison common to all the forms of typhus, which can, under different circumstances, produce different lesions and symptoms ; or is each variety caused by a distinct poison ? This question has been decided, in favor of those who hold that there is not one, but several distinct poisons which produce different forms of typhus. It is now agreed by almost every one, that among all the affections which have been called typhus, we can distinguish three different diseases, each of which is produced by a specific poison. These are exanthematous typhus (typhus fever), abdominal typhus (typhoid fever), and relapsing fever. The non-identity of the different forms of typhus was repeatedly asserted by different authors from 1830–40 ; but William Jenner, in England, and Griesinger, in Germany, were the principal advocates of this view ; and it is by their labors that the specific difference of these three diseases has been recognized. The Crimean war gave to the French an opportunity of studying exanthematous

typhus, and of distinguishing it from abdominal typhus. Jenner especially called attention to the fact that the poison of typhus fever, of typhoid fever, and of relapsing fever, in every case only produces the same disease, and never one of the others.

When this principle of an etiological classification was fairly carried out, it rendered necessary an entirely new grouping of the various cases of disease. The severe forms of febris nervosa, maligna, putrida, belonged, according to circumstances, to different diseases, and could no longer be considered identical. On the other hand, the lightest forms of continua simplex, of febris gastrica, etc., although often not accompanied with any typhoid symptoms, were to be classed with one or other of the forms of typhus, according to the particular poison by which they were caused.

Although at the present day this idea of a specific difference between these three forms of typhus is generally recognized, there is at the same time, a general belief that they are very similar to each other. They are looked on as members of the same genus, or of the same family. In the same way as we see in the exanthemata a natural group of different diseases which resemble each other in their symptoms, course, and mode of infection, so the typhoid diseases may be looked on as a group which includes typhus fever, typhoid fever, and relapsing fever, even the plague and yellow fever.[1]

But the very expression, "typhoid diseases," gives rise to the suspicion that this classification is only based on the old plan of considering principally the symptoms. And if we look more closely, we can see that this is really the case. Let us consider for a moment the relationship between typhoid fever and typhus fever. Perhaps even now most physicians consider these two diseases to be nearly related, and many even think that there may be transitions from one disease to the other. This idea has led to much unnecessary confusion. Facts observed in one of these diseases have been indiscriminately applied to both.

[1] Some authors even include puerperal fever, dysentery, hospital gangrene, diphtheria, and many other diseases, under the name of typhus. See *Eisenmann*, Die Krankheits familie Typhus. Erlangen, 1835.

The principal ground for this idea is the existence of the "status typhosus," which is found in both diseases. But the "status typhosus," as I have already endeavored to prove,[1] is by no means a symptom which necessarily attends these diseases and distinguishes them from others. It is entirely a result of the severe and long-continued fever, and is found equally in all diseases in which the fever has the same intensity and duration, as in many cases of variola, scarlatina, pneumonia, peritonitis, etc. On the other hand, the status typhosus is absent in all those cases of typhoid and typhus fever, in which the fever is less intense, or is held within bounds by proper treatment. If, however, the typhoid condition is not characteristic, no further ground is left for asserting the relationship of the "typhoid diseases." In fact the only likeness between typhoid and typhus fever, except that they are both infectious diseases, is that in both diseases many of the cases are attended with severe and long-continued fever. In every other respect they are different. Typhus fever has many more analogies with small-pox, measles, and scarlet fever, than with typhoid fever. Typhoid fever in its etiology and mode of propagation resembles dysentery and cholera much more than it does typhus.

The real, fundamental difference between the two diseases is this: Typhus fever is a purely contagious disease; typhoid fever belongs to the miasmatic-contagious diseases. Typhus can be transmitted directly from person to person; its contagion is as intense and evident as is that of the acute exanthemata. Typhoid fever, on the contrary, is never transmitted from person to person. There can be no doubt that this profound difference in the mode of propagation depends upon an essential difference in the poison producing the two diseases. Every classification, therefore, which is grounded on scientific principles, must separate these two diseases widely from each other.

It is certainly an evil that in Germany both these diseases have the same name; it can lead to confusion among beginners, and might well be corrected. But the propositions for a better nomenclature, which have as yet appeared, are worthy of but

[1] Deutsches Archiv für klinische Medicin. B. I. 543. 1866.

little attention. It is proposed by some to adopt the French and English names, to call exanthematous typhus, typhus,—and abdominal typhus, typhoid. The name typhoid, however, expresses the idea of a similarity between the two diseases; and furthermore, the Germans consider abdominal typhus as the typical typhus, so that such a change would hardly be an improvement.

Since the time when the typhoid diseases have been classified separately, the following are the most important synonyms of abdominal typhus: Abdominal nervous fever, ileo-typhus, darm-typhus, enteric fever, enteric or mesenteric typhus, febris entero-mesenterica, dothienenterie, fièvre typhoide (France), typhoid fever (England), intestinal fever (Budd), pythogenic (produced by putrefaction) fever (Murchison).[1]

HISTORY.

It cannot be determined when typhoid fever first made its appearance, but there is no reason to consider it of recent origin. Among the descriptions given by the ancients of the "typhoid diseases" we find some which correspond pretty closely with typhoid fever. Wunderlich[2], in his remarkable attempt to make a diagnosis of the cases related by Hippocrates in the first and third books of the Epidemics, pronounces several cases to be typhoid fever. I think it probable that some of these cases really do belong to this disease.[3] On the other hand, it is doubtful whether any of the different forms of dysentery and intestinal ulcers described by Aretaeus[4] belong to typhoid fever. The intestinal lesions in typhoid fever are not so striking, to those who make no autopsies and only observe symptoms, as to be considered an essential feature.

In later times, typhoid fever is to be found under the name

Throughout this article the English names of typhoid fever, and typhus fever, are used.—TRANSLATOR.

[2] Geschichte der Medicin. Stuttgart, 1859. Belege, Excurse und Notizen. S. 4.

[3] Haeser also is disposed to refer some of the descriptions in the Hippocratic writings to typhoid fever. New edition of Geschichte der Medicin. Bd. I. S. 168.

[4] De causis et signis chronic. morb. II., 9. *Ed. Kühn*, p. 153 sq.

of hemitritæus. We find in the seventeenth century descriptions of cases, sometimes with accounts of the autopsies, which show with hardly a doubt that typhoid fever was then widely spread in Europe. Such reports were given in Italy by Spigelius, Baglivi, and Lancisi; in England by Willis and Sydenham; in Germany by Friedrich Hoffman.[1] In the eighteenth century the existence of typhoid fever can be proven with certainty. The case given by Morgagni,[2] in which he describes ulcers and perforations in the lower part of the ileum and in the beginning of the colon, with swelling of the mesenteric glands and of the spleen, is generally recognized as an undoubted example of typhoid fever. Many other plain cases of this disease were described at this period, and more frequently still later, until at the beginning of the present century the French described epidemics of typhoid fever, with constant intestinal lesions.

It is probable that in earlier times typhoid fever was much less widely spread than at the present day. But no certainty on this point can be reached, for not only are all statistics wanting, but good descriptions of autopsies or symptoms are seldom met with.

The following account of typhoid fever is principally founded on the observations made by myself in the hospital at Basle, from 1865–71. During this time I treated 1,900 cases of this disease. The statistics given further on are principally drawn from these observations. It was, of course, not possible for me to go over all these histories anew and examine them in every point of view. In reference to certain questions I had already worked up most of the cases. Concerning many important points I have made notes; while colleagues, assistants, and students have employed for me both these observations and others made by me in previous years. This same series of observations has been already used by others in reference to certain points. My friend Prof. C. E. E. Hoffmann[3] has employed all the fatal cases from 1865–1867, together with some which were not under my care, in his very comprehensive work. In its therapeutical aspect the material has been principally employed by Prof. Hagenbach and myself.[4] The complications and sequelæ have

[1] Compare *Murchison*, l. c., p. 388. [2] Epistol. XXXI. 2.

[3] Unters. über die path.-anat. Veränderungen der Organe beim Abdominaltyphus Leipzig, Vogel. 1869.

[4] Aus der medicin. Klinik zu Basel. Beobachtungen und Versuche über die Anwendung des kalten Wassers bei fieberhaften Krankheiten. Leipzig, Vogel. 1868.—Ueber die antipyretische Wirkung des Chinin. Deutsches Arch. f. klin. Med. Bd. III., p. 23.

been treated of by Dr. Betke,[1] under my direction. The printed year books, prepared under my direction, by the assistant physicians, Dr. Massini, Dr. Breiting, and Dr. Nüssli, contain most of the material for the years 1869, 1870. For certain questions I could also use the observations made in Basle in the years 1871, 1872, which are described in the year books by Prof. Immermann and the assistant physicians Dr. Breiting and Dr. Socin.[2] In reference to etiological questions, an extensive series of statistics from cases in the hospitals at Basle has been compiled at my instigation, by Dr. B. Socin.[2] I have also employed, besides these hospital cases, numerous notes out of my private practice, as also my experience in other hospitals. The material which I have employed has been, therefore, unequally worked up, so that a greater or less number of cases was available to make up the statistics for the different questions which came up. But my familiarity with the entire series of observations enabled me to employ readily what was needful for each topic, and in all the more important questions as to the frequency of the occurrence of the various conditions, I have given the number of the cases referred to. I think that I am justified in saying that all the figures given are reliable, except for such errors as are inherent to the subject, and unless the contrary is stated.

In addition I have endeavored, so far as possible, to make use of the extensive literature of the subject, but in quoting I have confined myself to the more important proofs and statements.

ETIOLOGY.

W. Budd, Intestinal Fever essentially Contagious. Lancet, July, 1859.—Mode of Propagation, Relation to Defective Sewerage. Ibid., October.—The same Author in the Lancet 1856, 1861, and in Observations on Typhoid or Intestinal Fever: the Pythogenic Theory. British Medical Journal, 1861.—*Griesinger*, l. c.—*Murchison*, l. c.—*Trousseau*, l. c.—*L. Buhl*, Ein Beitrag zür Aetiologie des Typhus. Zeitschrift für Biologie. Bd. I. 1865.—*v. Gietl*, Die Ursachen des enterischen Typhus in München. Leipzig, 1865.—*Liebermeister*, Zur Aetiologie des Abdominaltyphus. Deutsche Klinik, 1866. Nr. 6.—*M. v. Pettenkofer*, Ueber die Schwankungen der Typhussterblichkeit in München von 1850 bis 1867. Zeitschr. f. Biologie. 1868.—Ueber die Aetiologie des Typhus. Vorträge, gehalten in den Sitzungen des ärztlichen Vereins in München. München, 1872.—*A. Biermer*, Ueber Entstehung und Verbreitung des Abdominaltyphus.

1867.—Bericht über die Resultate der Behandlung des Abdominal Typhus in Spital zu Basel. Ibidem. Bd. IV., p. 413. 1868.—*Nüssli*, Die Resultate der Kaltwasserbehandlung des Typhus abdominalis im Baseler Spital im Jahre 1869. Dissertation. Basel, 1871.

[1] Die Complicationen des Abdominaltyphus. Statistische Zusammenstellungen nach den Beobachtungen im Spital zu Basel in den Jahren 1865–1868. Dissertation. Abgedruckt in der Deutschen Klinik 1870. Nr. 42.

[2] Typhus, Regenmenge und Grundwasser in Basel. Dissertation. Basel, 1871.

Sammlung klinischer Vorträge. Nr. 53.—*Lindwurm*, Ueber Typhus-Recidive und Typhus-Infection. Aerztl. Intelligenzblatt. 1873. Nr. 15 u. 16.

The assertion that typhoid fever belongs to the miasmatic contagious diseases, in the sense defined in the introduction to the infectious diseases, includes two minor assertions. Either of these assertions, if strictly carried out, may, perhaps, meet with contradiction. It is stated, on the one hand, that typhoid fever is never directly transmitted from person to person; and, on the other hand, that it never occurs spontaneously, but is always due to a disease germ, originating in some other case of typhoid fever. It will be necessary to bring forward the facts on which these assertions are based.

The reason why most persons are so slow to believe that typhoid fever is never directly transmitted from person to person, is, that they are unable to free themselves from the idea of a relationship between typhus and typhoid fevers. Typhus fever is certainly a disease which can serve as a prototype of those diseases which are directly transmitted from person to person. Whoever touches, or even comes near to a case of this disease is in danger of contagion. For this reason the greater number of the physicians and attendants who take care of such invalids are themselves attacked by the disease. In Ireland, in the year 1847, no less than 500 medical men—about one-fifth of the entire number—suffered from typhus, and of these 127 died (Murchison). In the Crimean war, at the height of the epidemic among the French, out of 840 attendants in 12 hospitals, 603 were taken sick during a period of 57 days; more than 80 surgeons died of the disease in the course of the campaign (Griesinger). Niemeyer in one epidemic was obliged to employ a former felon, who had just recovered from the disease, as nurse, because all the attendants were sick. Similar experiences have occurred in all the epidemics of typhus fever. In hospitals, unless those attacked with this disease are strictly isolated, they will infect large numbers of the other patients.

Entirely different from all this is the mode of propagation of typhoid fever. All observers, without exception, are at least of accord that in comparison with the contagion of typhus, that of

typhoid fever is very slight, and that direct contagion from person to person is not the rule in the latter disease. From a long experience I do not hesitate to go still farther, and to assert that the opinion that typhoid fever can be purely contagious, and can be transmitted directly from person to person, is not founded on actual observation. Such an opinion is only a relic of the past time, when the proper distinction between typhoid and typhus fever was not made, and when whatever was proved of the one disease was supposed to be partly true of the other. Typhoid fever, in reality, is never directly transmitted from person to person.

In support of this opinion is the fact that one can handle patients suffering from typhoid fever without danger of contagion. Physicians and nurses, who take care of such patients, are no more frequently attacked with the disease than are persons who have never seen such cases. Up to the year 1865 I have never seen, in the hospitals which I visited (Greifswald, Berlin, Tübingen), a single hospital patient, physician, or nurse attacked with typhoid fever, although such cases are placed in the general wards. Other observers have had the same experience. According to Murchison, during a period of fourteen and a half years in the London Fever Hospital, 2,506 patients with typhoid fever were treated, and during that time only eight cases originated in the hospital.

There are, indeed, a number of contrary observations, and it may be that in some particular hospital the disease originates more frequently. If this only happens during an epidemic, and the number of such cases is not great, the fact is not remarkable. But even if, as an exceptional thing, the cases originating in the hospitals are very numerous, this must not be considered of itself sufficient proof of direct contagion. The possibility exists that local conditions are the cause. If a focus of infection exists within a hospital, it may give rise to numerous diseases. It is easy to understand, from what we know of the origin of infection, that in a hospital where there are many cases of typhoid fever, such a focus of infection may readily be formed.

Since 1865 I have often had the opportunity to see such

hospital infections. But these observations have only strengthened my belief that there is no direct contagion from person to person.

In the hospital at Basle, during my service from 1865 to 1871, such hospital infection occurred repeatedly, more frequently in the earlier than in the later years. During this period of six years, 1,900 cases of typhoid fever were treated; of these, in 45 cases, the disease originated in the hospital. Besides these, slight febrile affections occurred among the attending physicians and nurses, which were in part due to slight infection. Of the 45 cases some were nurses or attendants, who were in contact with the typhoid patients; others were patients lying in the same wards. But some of the cases were in persons who had no direct or indirect communication with the typhoid patients. For example, a patient who had gone through an attack of small-pox in the isolated wards devoted to that disease, was attacked immediately after his discharge with fatal typhoid fever. Another patient was attacked in the syphilitic wards, which are also isolated, and that, too, at the end of a vigorous course of treatment with calomel. In the surgical wards some patients were attacked. The apothecary also, the engineer, washerwomen, and kitchen maids, none of whom ever entered the wards, were attacked in the same way. Such cases show evidently that typhoid infection within a hospital does not depend upon direct contagion from person to person. On the other hand, many other circumstances pointed to the fact that foci of infection had been established in the hospital. Thus, for example, the cases of the disease among the attendants and patients were especially numerous in two rooms, which were situated one over the other on different floors. A wooden pipe, which extended from the main sewer to the roof, ran by both these rooms. At that point the sewer was of faulty construction and was turned at a right angle, so that the refuse matters accumulated there. Since this source of infection was made known, repeated cleansings, washings, and disinfections have been followed by satisfactory improvement, and if the sewer were entirely altered the infection would disappear. During 1872 and 1873 I am informed by Prof. Immermann that there were six to eight cases of typhoid fever among the physicians and attendants of the hospital; and besides this, almost all the new attendants suffered from abdominal catarrh without fever.

In the hospital at Tübingen, during the year 1873, five persons were attacked with typhoid fever, and two of these were very sick. It was remarkable that none of these cases occurred among the attendants or patients of the medical service who came in contact with the typhoid patients. On the contrary, all the cases occurred in the patients on other stories, who never saw a typhoid patient (one case in the warden's family, a kitchen maid, three surgical nurses). It should be mentioned in this connection that the water-closets of this hospital are very badly arranged, and are not likely to be improved until a new hospital is built.

In accordance with these facts is an experience of Griesinger's, which, however, he interpreted as a proof of the direct contagion of this disease. He observed in

the hospital at Zürich that although the typhoid patients were isolated, yet convalescents and patients in other parts of the building were attacked with the disease.

These observations, to which others could be added, show plainly that hospital infection is not to be explained by contagion from person to person. In a hospital which is only tolerably clean, it makes no difference whether the typhoid patients are isolated or placed in the same ward with the others. Hospital infections do not depend upon direct contagion, but indicate that foci of infection exist within the hospital.

We meet with similar experiences in private practice. There are indeed often enough cases in which one could suppose a direct contagion; but a closer observation shows that the assumption of another way of infection is not only possible but usually more probable. In addition, there are numerous cases in which the possibility of infection by direct contact can safely be excluded.

Already, at a time when typhoid and typhus fevers were not recognized as entirely distinct diseases, two opinions prevailed among physicians as to the contagiousness of typhoid. The one party asserted decidedly that according to their experience typhoid fever was not contagious; these were principally the French, whose experience was confined to typhoid fever. Thus Andral declared that he had never seen anything in hospital or private practice which pointed to the contagiousness of this disease. Chomel asserted that not one French physician in a hundred believed the disease to be contagious. But most physicians and especially those who were acquainted with typhus fever, asserted that typhoid fever was also contagious, and this opinion became gradually the prevailing one. Only very lately, since the two diseases have been separated, do we find observers freeing themselves from the conclusion drawn from the analogy falsely assumed between the two diseases, and reaching the conviction that typhoid fever is not contagious from person to person.[1]

How then does typhoid fever originate? How is the poison

[1] Compare *V. Gietl*, l. c., "Der reingehaltene Leib des Typhuskranken und dessen Leiche stecken nicht an." See also *Liebermeister*, l. c.—*Biermer*, l. c.

elaborated, and how is it transmitted to man? These questions are answered with great unanimity by most persons, even those who believe in direct contagion. They hold that the poison of typhoid fever originates in the decomposition of organic substances. The name pythogenic (produced by putrefaction) fever, proposed by Murchison, is based on this generally received opinion.

Yet, if we look more closely at the facts on which this pythogenic theory rests, we can find grounds for doubt.

In the first place, it appears suspicious that not only typhoid fever, but a whole series of specific diseases, of which the origin is obscure, should be all referred to the decomposition of organic substances. Such an origin is often assumed for the plague, dysentery, malarial diseases, yellow fever, typhus and cholera. And this very circumstance shows that to explain the origin of typhoid fever by a general and indefinite assumption of a decomposition of organic substances is not satisfactory. It is not every kind of decomposition that can produce typhoid fever; it must be some specific form of decomposition which elaborates as a specific product the poison of that disease.

To explain the formation of such a specific product, two principal hypotheses have been offered. The one assumes that the specific products of decomposition depend on the particular substances which are decomposed. To produce typhoid fever, the substances decomposed must be animal. To fæcal masses especially, and above all to human excrements, is attributed the property of producing typhoid fever, by their decomposition. More recently the gases from sewers have been regarded as a frequent cause of typhoid fever. According to the other hypothesis, typhoid fever originates in the decomposition of organic substances only when these decomposing substances are mixed with the germs of the specific typhoid poison, and when these germs grow and multiply.

An unprejudiced examination of the facts leaves no doubt as to which of these hypotheses corresponds best with observation. A few hints will suffice here.

Typhoid fever has never been produced by experiments with decomposing substances, nor by products of decomposition acci-

dentally introduced into the body. It would be an entire misunderstanding of the specific character of typhoid fever to confound with it, in any way, the appearances and intestinal affections which are produced by the inoculation of putrid substances.

There are, indeed, several accounts in the annals of science, of the production of typhoid fever by eating rotten food. The most striking of these is the epidemic which occurred in Andelfingen, in the Canton of Zürich, in 1839, when, it was said, more than five hundred persons were attacked with typhoid fever in consequence of eating putrid meat. Griesinger, by bringing forward this fact, and by stating that the existence of ileo-typhus was anatomically proven, has made this epidemic widely known, so that it is generally accepted as a proof of an autochthonous origin of typhoid. In this way, some authors who were disposed to believe in the continuous propagation of the typhoid poison, were led to the assumption of its spontaneous origin. The importance of this case, if it were fully proven, in reference to the etiology of typhoid fever, has led me to study closely the printed records of this epidemic. And I found, with complete certainty, that this epidemic, in which out of five hundred and fifty cases nine or ten died, was not typhoid fever.[1] On the other hand, my belief that it might have been an unusual epidemic of trichinosis, a belief which had been laid before the medical authorities of Zürich by Küchenmeister, was not confirmed. Dr. Sigg, Jr., of Andelfingen, examined the bodies of two of the fatal cases, and found no trichinæ. This gentleman was kind enough to give me a portion of the muscular tissue of a man eighty-one years old, who died in this epidemic, and I was unable to find any trichinæ.[2] This negative result, together with other more recent occurrences, render probable the opinion that there is a particular disease produced by meat-poisoning, an idea already advanced by Lebert[3] and R. Köhler.[4]

In fact, daily observation is sufficient to show that the decomposition of organic substances and of excrementitious substances is not of itself sufficient to produce typhoid fever. There are multitudes of houses in which the effluvia of the privies can be smelt through all the rooms, and in which the inhabitants are constantly inhaling sewer gases; and neither the temporary nor permanent residents are attacked with typhoid fever. Cities with defective sewerage are not by any means always visited with typhoid. It can be readily seen also that

[1] Ueber die Epidemie in Andelfingen (Canton Zürich), vom J. 1839. Deutsches Archiv für klin. Medicin. Bd. III. 1867. S. 223.

[2] Notiz betreffend die Epidemie in Andelfingen. Ibid. Bd. IX. 1872. S. 245.

[3] Handbuch der praktischen Medicin. Bd. I. 1 Aufl. S. 415. 3 Aufl. S. 434.

[4] Handbuch der speciellen Therapie. 3 Aufl. Bd. I. Tübingen, 1867. S. 5.

there is no relative proportion between the frequency of typhoid fever and the want of cleanliness in different cities; the dirtiest cities may be exempt, and the cleanest attacked. There are villages, and there are certain quarters in cities where, both within and without the dwellings, decomposition of organic and excrementitious substances is constantly going on; but only in some of these situations does typhoid fever occur; while in others it has never been observed within the memory of man. But in such places the introduction of a single case of typhoid will often give rise to a severe epidemic.

We are, therefore, forced to the conclusion that, besides external conditions favorable to the development of the typhoid poison, something else is necessary. Numerous facts render it more than probable that this something necessary is the specific poison itself. In other words, the poison of typhoid fever does not originate in decomposing substances, but finds in them a favorable ground for its growth and multiplication. The most convincing experiences show that typhoid fever never originates in any unusual amount of decomposing matter, nor from any circumstances favorable to decomposition, but is always preceded by the introduction of a case of the same disease.

This opinion, that the poison of typhoid fever is propagated continuously and never originates autochthonously was first established by Budd. It has gained ground as yet but slowly, but there is every prospect that it will in time become the prevalent opinion.

In most large cities typhoid fever is endemic, and more or less cases are constantly seen, so that in them the result of the introduction of the disease can hardly be traced. In small places, however, it sometimes happens that after a long immunity from the disease a single case will be introduced which gives rise to an extensive epidemic, and for years after this there will be single cases or repeated epidemics. The number of such examples as this is constantly increasing. Thus Trousseau gives a number of such cases occurring in France; while Budd and Murchison relate similar experiences. V. Gietl has published some very interesting observations. De la Harpe[1] reports on an

[1] Bulletin de la société Vaudoise de médecine, Juin, 1867. Nr. 3.

epidemic in Lausanne, from which numerous cases found their way into the adjoining villages and there gave rise to new epidemics. Recent literature furnishes many more examples, so that we can lay it down as a rule without exception that typhoid fever only appears in a locality previously free from it, when a case of the same disease has been introduced.

I have myself had several opportunities to follow such introductions of the disease. The spread of typhoid in the villages of the Jura belonging to the Canton of Baselland, was particularly interesting. There one could repeatedly determine that a case from Basle, or from Aarau, or from some other village where the disease existed, was the starting-point of a new epidemic. Whilst in many of these villages, all in the same hygienic condition, typhoid had not been seen before in the memory of man.

Such experiences are usually explained by authors as evidences of the contagiousness of typhoid. For us they are the proof that the decomposition of organic substances is not of itself a sufficient cause for typhoid fever; for in the villages just mentioned such decomposition had been going on for ages. It requires the presence of the specific poison, a poison which is introduced and not developed spontaneously, and this specific poison finding an appropriate soil produces an epidemic.

We must therefore recognize, on the one hand, that typhoid fever is never contagious from person to person, and on the other hand, that it never originates spontaneously, but by a continuous transmission of the poison. Typhoid fever, therefore, like cholera and dysentery, belongs to the miasmatic contagious diseases, in the sense in which these diseases were defined in the introduction. The disease is not contagious in the proper sense of the word, for it is never transmitted by direct contact. It is not purely miasmatic, for external conditions alone are not sufficient to produce it. The presence of a person suffering from this disease, or of substances derived from such a person, is necessary. The poison is propagated continuously. It travels from the diseased individual to the localities which are favorable for its growth and multiplication, and from these localities again into the human body.

The question then arises, What are the substances derived from diseased individuals which act as transporters of the poison? Evidently these substances are to be looked for in the excrements. There are the same grounds for looking for the poison in the excrements in typhoid fever as there are in cholera. And as a matter of fact, there are very plain observations which show that the disease can be produced from the excrements of typhoid patients. But it may be questioned whether such excrements contain the poison while still in their fresh condition. The circumstance that physicians and nurses and patients in the same wards are seldom attacked, even if they handle the fresh excrements, seems to indicate that the poison, in order to become active, has to go through a certain stage of development outside of the body. This development can take place if the dejections are left to themselves, as in dirty linen ; but it seems to go on more abundantly if the dejections are collected in privies, sewers, or ground already saturated with organic substances. In this way it can be explained how a typhoid patient, who comes to a house or region previously free from the disease, can establish there a focus of infection from which many other persons become diseased.

Often such a focus of infection is so limited that only the inhabitants of one or of a few houses are exposed to its influence. And even in extensive epidemics it is often plain that the epidemic is composed of a great number of endemics. Certain portions of a city, groups of houses, or even single houses, represent foci of the disease, while other houses between these are not affected. Of 436 typhoid patients received in the Zürich hospital, Griesinger could determine that 135 came from houses in which one or more other persons were sick with the disease. Similar relations were observed in the epidemic which prevailed in Basle in the years 1865 and 1866. According to the report of Streckeisen,[1] on this epidemic, a report which, in spite of some inexactitude in the statistics, contains much useful material, the number of reported typhoid cases in the two years was

[1] Bericht an E. E. Sanitäts-Collegium von Basel-Stadt über einige statistiche Verhältnisse der . . . Typhus-Epidemie. Basel, 1868.

2,847. If the trivial cases, called febrile abdominal catarrh, are included, the entire number reached 3,756. Of all these it was shown that 962 cases were brought from houses in which three or more cases of the disease existed.

To form a judgment of the proof afforded by such statistics an approximative balancing of the figures is not sufficient. It is necessary to consider the balance of probabilities. The statistics just mentioned are by no means sufficient. It requires a more exact study of the groups of cases than can be undertaken here to demonstrate the existence of separate foci of infection.

The poison of typhoid fever can retain its vitality for a long time during the stage of development through which it passes outside of the body. Whilst the poison of cholera, in our climate at least, usually expires in a few weeks outside of the body, the poison of typhoid fever may live for a long time under the same circumstances. When typhoid fever is once established in any locality, it may disappear for a long while, and then suddenly reappear, without the introduction of a new case. In Basle, during the first five months of the year 1865, there were only a few isolated cases of typhoid fever (twelve cases in the hospital in five months). In the following months occurred the most extensive epidemic ever seen in that city. There were one hundred and fifty cases in the hospital wards; one hundred cases in a temporary hospital, and the hospital accommodations were entirely insufficient for the number of cases. It was evident that during the almost complete cessation of the disease the poison remained latent, but not dead, outside of the human body. Similar experiences are seen in all large cities in which typhoid fever is endemic, and it is well known that dysentery occurs in cities and villages under similar conditions.

Many observations also of smaller foci of infection point to a long-continued existence of the poison outside of the body. Griesinger calls attention to the protracted and scattered house epidemics, in which the cases occur at intervals of months, so that their mutual connection is easily overlooked. Murchison relates an example of six cases occurring in the same house, scattered over a period of eight years. Although, when the cases occur at such long intervals, their connection may be

doubted; yet in many cases it is most probable that there is a continuous focus of infection producing occasional cases of disease.

By the assumption of a long existence of the typhoid poison outside of the body, most of the single cases, which are used as proofs of the autochthonous origin of typhoid fever, can be brought into accordance with our theory of a continuous transmission of the disease. So strong are the proofs in favor of the long vitality of the typhoid poison, that we must scrutinize very closely the cases which are brought forward in favor of the autochthonous theory.

The period of incubation, that is, the length of time during which the poison remains in the body before symptoms of the disease are manifested, is difficult to be determined. It is hard to fix the exact date of the infection, and often hard to fix that of the commencement of the disease. It is customary to include the time of the indefinite prodromata in the period of incubation, and to reckon the commencement of the disease from the time when the fever or some of the peculiar symptoms make their appearance. There are some cases in which it seems probable that the period of incubation is relatively short. It happened in Basle that a few cases were attacked who had only been in the city from seven to fourteen days. In the epidemic which was produced at the barracks in Solothurn by the drinking-water, one person was taken sick fourteen days or less after exposure, seven others in sixteen to seventeen days or less. On the other hand, in most cases the period of incubation seems to be longer. In one case I could determine that it lasted at least nineteen days, in other cases at least eighteen days. Lotholz,[1] who worked under Gerhardt's direction, observed in the epidemic which occurred in the neighborhood of Jena, that the average period of incubation was three weeks; the shortest period eighteen days, the longest twenty-eight days. Haegler[2] found in three cases, produced by drinking-water, a period of incubation of at least twenty-one days. According to our pres-

[1] Beitrag zur Aetiologie des Ileotyphus. Dissertation. Jena, 1866.—*Gerhardt*, Deutsches Archiv f. klin. Med. Bd. XII. 1873. S. 5.

[2] Deutsches Arch. f. klin. Med. Bd. XI. S. 24.

ent experience, therefore, the average period of incubation is three weeks; in isolated cases it may be only two weeks, and in others last as long as four weeks.

In what way is the poison received into the human body? This question is very important. Its answer might show to those who live where typhoid fever is endemic, how to avoid the disease. In most cases we are not able to answer this question, yet we can demonstrate by reliable observations two special ways of infection. Infection can be produced by the air we breathe, and by the water we drink.

With our present experience it is not possible to deny the production of infection by the air. When we find that most of the scholars in some schools are attacked with typhoid fever in a succession and intensity corresponding to the degree of their exposure to the gases arising from an open sewer (Murchison, l. c., p. 443), we can hardly doubt the way in which the infection is produced. Similar experiments, in which the spread of the infection by the air seems the only possible way, are not uncommon. In the cases in the hospital at Basle, an infection from drinking-water could be safely excluded, and I have often seen cases of typhoid under conditions which seemed to exclude every other way of infection except by the air.[1]

A very instructive case is related by v. Gietl, which shows at the same time the long vitality of the typhoid poison. A villager, who had contracted typhoid fever at Ulm, returned to her native village, a place where typhoid had not existed for many years. The excrements of this person were thrown on the dunghill. Several weeks later five persons were employed to remove this dunghill. Of these five, four were attacked with typhoid fever, and one with gastric symptoms and swelling of the spleen. The excrements of these five persons were buried deep in the dunghill. Nine months later, two persons were employed in completely removing this dunghill, one of them was attacked with typhoid and died of it.

From such facts we may fairly assume that infection can be produced by the inhalation of the exhalations from privies, sewers, etc., in which the typhoid poison exists. It is hardly necessary to mention that the existence of infection by the way of inspiration does not imply that the poison is a gaseous body.

[1] Deutsches Arch. f. klin. Med. Bd. VII. 1870. S. 180.

On the contrary, it is most probable that the infectious agent consists of minute particles of solid matter suspended in the air. The inspiration of the poison, moreover, does not imply that it passes through the lungs into the blood. It is equally possible that it passes through the pharynx into the alimentary canal.

Often the disease seems to be spread by the bed linen and the clothes dirtied with the dejections of the patients. This explains why washerwomen are so frequently attacked; and why the relatives who nurse the patient are so often the first victims. De la Harpe found that the first series of persons infected by an imported case of typhoid fever were almost always females.

The greater number of physicians admit the occurrence of infection from drinking-water. But there are some authors, and very good ones, who, if they do not entirely reject this mode of infection, yet regard it as unproven, or of very rare occurrence.

To unprejudiced minds there can be no doubt of the frequent occurrence of infection from drinking-water. There are a very large number of experiences recorded in literature, which render this assumption at least possible and often very probable. Besides, there is a series of indubitable facts, any one of which would alone be sufficient for proof. It is not going too far, if we assert that the infection from drinking-water can be more clearly proven than the infection from the air. The experiences of later years have been so striking, that even the wonderful dialectics of Pettenkofer cannot raise a doubt against them.

In the first place, it is certain that there are many wells into which drain the matters from adjoining privies. When we consider how often wells and privies are situated close to one another, and how little precaution is taken to prevent the contents of the privies from soaking into the surrounding earth, we should expect, as a matter of course, that these foul matters must find their way into the deeper springs. Very often, also, chemical analysis will detect in well-water substances which can only come from neighboring privies.[1] In some cases, where

[1] Compare the extended researches of *G. Goppelsroeder*, Ueber die chemische Beschaffenheit von Basels Grund-, Bach-, Fluss-, und Quellwasser, mit besonderer Berücksichtigung der sanitarischen Frage. Separ.-Abdruck. aus den Verhandlungen der Baslerischen naturforschenden Gesellschaft. Basel, 1867.

typhoid patients were crowded together in houses, I have been able to make ocular demonstration of the flow of foul matters from the privies into the wells.

If, therefore, we hold the dejections of typhoid patients to be the carriers of the contagion, it is *à priori* probable that they become mixed with the drinking-water. In fact, in Basle many epidemics had to be referred to such conditions, and often the closing of the wells, and the use of the drinking water from the aqueduct, was sufficient to break up the epidemic.

It must be understood, however, that not all well water which is mixed with drainings from privies produces typhoid fever; the presence of the typhoid poison is a necessary condition. In a region where there is no typhoid fever, the drinking of excrementitious matters does not produce typhoid, but, at the most, only other derangements. In this way we explain the common experience that a well may furnish harmless water for a long time, and then, if a single case of typhoid is introduced, gives rise to an epidemic. In general the quantity of organic matters present in drinking-water is not as important as their quality. And it is only from our want of knowledge of the quality that we are obliged to assert, in a general way, that drinking-water is suspicious according to the amount of organic substances in it, especially if these substances are excrementitious. Finally, we should mention that so far all observations favor the assumption that the typhoid poison can be destroyed by boiling the water.

Much more extensive than the epidemics produced from a single well are those which take place when an aqueduct is infected with the typhoid poison. Such occurrences have been repeatedly observed in late years. I had the opportunity of studying on the spot one of the most remarkable of these, the epidemic in Solothurn, in the year 1865. Such infection of an aqueduct is most easily effected when excrements from privies containing the typhoid poison are used as manure on the fields from which the aqueduct receives its supply. In this way originated the epidemic in Stuttgart, in the year 1872. Many facts, as, for example, the epidemic in Lausen (Canton Basel-land), in 1872, show that excrements and water polluted with

them can soak through a considerable thickness of earth without losing their infectious properties, especially if the earth is loose rubble.

A portion of the literature concerning infection from drinking-water was collected by Griesinger (l. c., 2. Aufl., p. 156). The yearly reports of Hirsch are the principal authorities for the last few years.

I give below a condensed account of some remarkable experiences of infection by drinking-water; for the details I must refer to the original reports.

Epidemics from Infection of an Aqueduct.

Epidemic in Solothurn, 1865. In a locality supplied by a certain aqueduct, during the period between August 15 and September 15, a number of persons were attacked with typhoid fever; 82 of these cases are described with their names. Almost all the houses supplied with water from this aqueduct contained cases of typhoid, while other houses near and between these, but with a different water supply, escaped entirely. In the barracks, which were supplied from the aqueduct, numerous cadets and instructors, collected from ten different cantons, were attacked with the disease. The disease commenced 14 days after their moving into the barracks; in 11 days, 32 were attacked, and the school being then given up, after its dismissal 10 more were attacked. Out of 100 persons 42 were attacked with severe typhoid, and 8 died. At the same time the disease appeared among the other dwellers in the barracks, although before that time there had never been a case of typhoid there. It was found, on examination, that a brook which passed through the court of the lunatic asylum Rosegg, and received its sewerage, ran into the aqueduct. In the asylum was a nurse who had recently come from a typhoid locality. This woman was taken sick with typhoid fever about the middle of July, and died August 8. The clothes of this patient were washed in the wash-house of the asylum, by order of the director, and many soiled clothes were even soaked in the brook itself. After the middle of August the epidemic appeared throughout the entire locality supplied by the aqueduct. (Deutsches Arch. f. klin. Med. Bd. VII. 1870, p. 168).

Epidemic in Lausen (Canton Baselland), 1872. The village of Lausen, since the passage of the allied armies in 1814, had not suffered from any epidemic of typhoid. Isolated cases introduced from Basle had never spread the infection. During the last seven years there had been no cases at all of typhoid. On the 7th of August 10 inhabitants were attacked with typhoid fever, and in the 9 days following 57 persons were seized. The epidemic lasted until October. Out of the 800 inhabitants of the village, 130 were taken sick, almost 17 per cent. Nearly 100 of these cases commenced during the first three weeks of the epidemic. In addition, 7 persons temporarily living in the village were attacked, most of them some time after their departure from it. The disease appeared only in those houses which were supplied with drinking-water from running streams. The houses which only used well-water escaped. It was demonstrated that the privy and dunghill of a house at some distance

discharged their contents into a little stream. This little stream had a subterraneous communication with the sources of the streams which ran into the village. In this house, on July 10th, a man was attacked with typhoid, and in July there were three more cases in the same house. (*Haegler*, Deutsches Arch. f. klin. Med. Bd. XI. 1873. S. 237. Vgl. *Gutzwiller*, Schweizerisches Correspondenzbl. 1872. Nr. 24.

Epidemic in Stuttgart, 1872. The meadows, from which a portion of the Stuttgart aqueduct receives its supply, were in the beginning of the winter of 1871–72 thickly manured with the matters taken from the city sewers. In January there was a thaw with rain, and the water of this aqueduct became of a yellow color, with an offensive smell. This was not produced by inorganic substances, and examination showed the presence of large quantities of organic matter. The water reduced a permanganate solution as much as would a mixture of pure water with ½ per cent. of urine. In February an epidemic broke out in the portion of the city supplied by this aqueduct, so severe that there was an average of one typhoid patient for every two houses. In a neighboring district, partly supplied with water from the same aqueduct, there was an average of one patient to every ten houses. In the rest of the city the disease was not more frequent than at ordinary times, averaging one case to every 144 houses. (*O. Koestlin*, Württembergisches ärztliches Correspondenzbl. 1873. Nr. 3. Berichte von *Burkart* und von *Frölich*, ibid., 1872. Nr. 2–15.)

We find reports of analogous observations during the last few years, showing the origin of such epidemics from infection of the water supply in *Zuckschwerdt*, die Typhusepidemie im Waisenhause zu Halle an der Saale im Jahre, 1871. Halle, 1872.—*M. Bansen*, Ueber Aetiologie des Typhus abdominalis. Züricher Dissertation. Winterthur, 1872.— *Weinmann*, Schweizer Corresp.-Bl. 1872. Nr. 23.—*Biermer*, l. c.—*G. E. Weisflog*, Ueber die Typhusepidemie von 1872, zu Elterlein. Deutsch. Archiv f. klin. Med. Bd. XII. 1873. S. 320.

Epidemics from Infection of a Well.

Epidemic in the "Soherenfabrik." in Basle, 1867. In a collection of houses situated at some distance from the city, of which the inhabitants numbered about 150, mostly girls of thirteen to seventeen years old, there were no cases of typhoid during the severe epidemic at Basle in 1865–1866. In the year 1867, when the epidemic had subsided in the city, a single case appeared in January; a second case in February, and in May a large number, so that within twenty-two days thirty-six persons were attacked with typhoid fever, and many others with febrile and afebrile abdominal catarrh. It was shown that the well from which the drinking water was drawn was fed from a canal into which emptied the privy. Eighteen days after the use of this water was forbidden there were no more new cases. A little later, three more cases occurred in persons who had probably disobeyed and drunken of the water. After the well was completely closed there were no more cases. (Deutsches Arch. f. klin. Med. Bd. VII. S. 155.)

Epidemic in the barracks at Zürich, 1865. In these barracks thirty-three recruits of the infantry school were attacked within seven days. After the dismissal of the

recruits, twenty-two more were seized. All the cases occurred in the infantry school; the members of the artillery school and the police stationed in the same barracks were exempt from the disease. The cause was found in a well, situated in the exercise-ground, only used by the infantry, from which they frequently drank. Close to this well was a receptacle into which were thrown refuse matters from the city. Chemical analysis showed the water to contain impurities from this receptacle. When the well was closed, and the refuse removed, no more typhoid appeared in the barracks. (Ibid., S 168.)

Compare also cases in *Murchison* (l. c.), *v. Gietl* (l. c.), and *Küchenmeister*, Der Reinhardtsdorfer Typhus, 1872–1873. Allg. Zeitsch f. Epidemiologie. Heft 1.

It is unnecessary to say that other beverages, such as milk, if mixed with infected water, and not boiled, can produce the infection. Observations, which seemed to show the propagation of typhoid fever by milk, have recently been made in England.

From all that has been said it results that the real cause, in our opinion, of every epidemic, and of every isolated case of typhoid fever, is only the specific poison of typhoid fever. All the numerous conditions which have been called causes are not real causes. If the specific poison is absent, every other evil influence may act on the population without producing typhoid fever. No matter how well a field is manured, wheat will not grow unless wheat has been sown. But no one would think for that reason of denying the importance of the quality of the ground and of the manure for the culture of wheat; if we sow on rocks we sow in vain. In the same way, besides the presence of the typhoid poison, many other conditions are necessary to produce typhoid fever. It happens, indeed, very often that the introduction of a case of typhoid does not produce an epidemic, and this is not at all remarkable. The germs of the poison, which come from the sick, must find a favorable soil for their reception and growth, and they must then be taken into the systems of other persons, in order to produce an epidemic. Whether this happens or not, depends upon many circumstances, especially such conditions as we commonly call fortuitous and accidental. We may, with the same reason, call it chance, whether any one kernel of corn falls in the furrow and grows, or falls on the road and is eaten by the birds. In the same way we see that typhoid does not occur with the same frequency in the different localities where it is endemic; and that in each

locality epidemics are not always occurring, but that there are alternations. Sometimes the cases are numerous, sometimes scanty, sometimes the disease seems to be latent. Besides the presence of the poison, therefore, there must be other circumstances on which it depends whether typhoid is of frequent or rare occurrence. If we were more intimately acquainted with the nature of the poison and the conditions of its development, we might reckon *à priori* some of these conditions. In the present state of our knowledge we must be contented to state some of them as matters of experience, while we ascribe many, sometimes most, to chance. Finally, every one who receives the typhoid poison is not necessarily attacked with the disease. For the individual also, besides the reception of the poison, other circumstances are necessary to develop the disease.

All the conditions which favor the development of an epidemic, or of the disease in isolated cases, have been often called "assisting causes." It is more correct to avoid for them the name of cause altogether; for all these assisting causes, taken together, are of no effect if the real cause is absent. We will rather speak of a *local disposition* for the production of an epidemic, and of an *individual disposition* for the development of the disease. By a change of circumstances both of these dispositions may change in the course of time, and in this sense we may also speak of a *periodical disposition.*

The *local disposition* to the development of epidemics of typhoid fever depends on a great number of conditions, and these conditions may combine in manifold ways. Many a single condition may be of no consequence in itself, and yet be decisive when combined with others. In a locality, for example, where the drinking-water is taken from wells, the character of the deep springs is of importance, and this character depends on many different circumstances: whether the privies, dunghills, etc., soak through to these springs or not; how the compact and impervious strata of the ground lie; whether the higher strata are compact or loose, etc. In a place where only spring-water is used for drinking, the character of the deeper strata and of the deep springs is of secondary consequence. The probability of the development of an epidemic depends upon

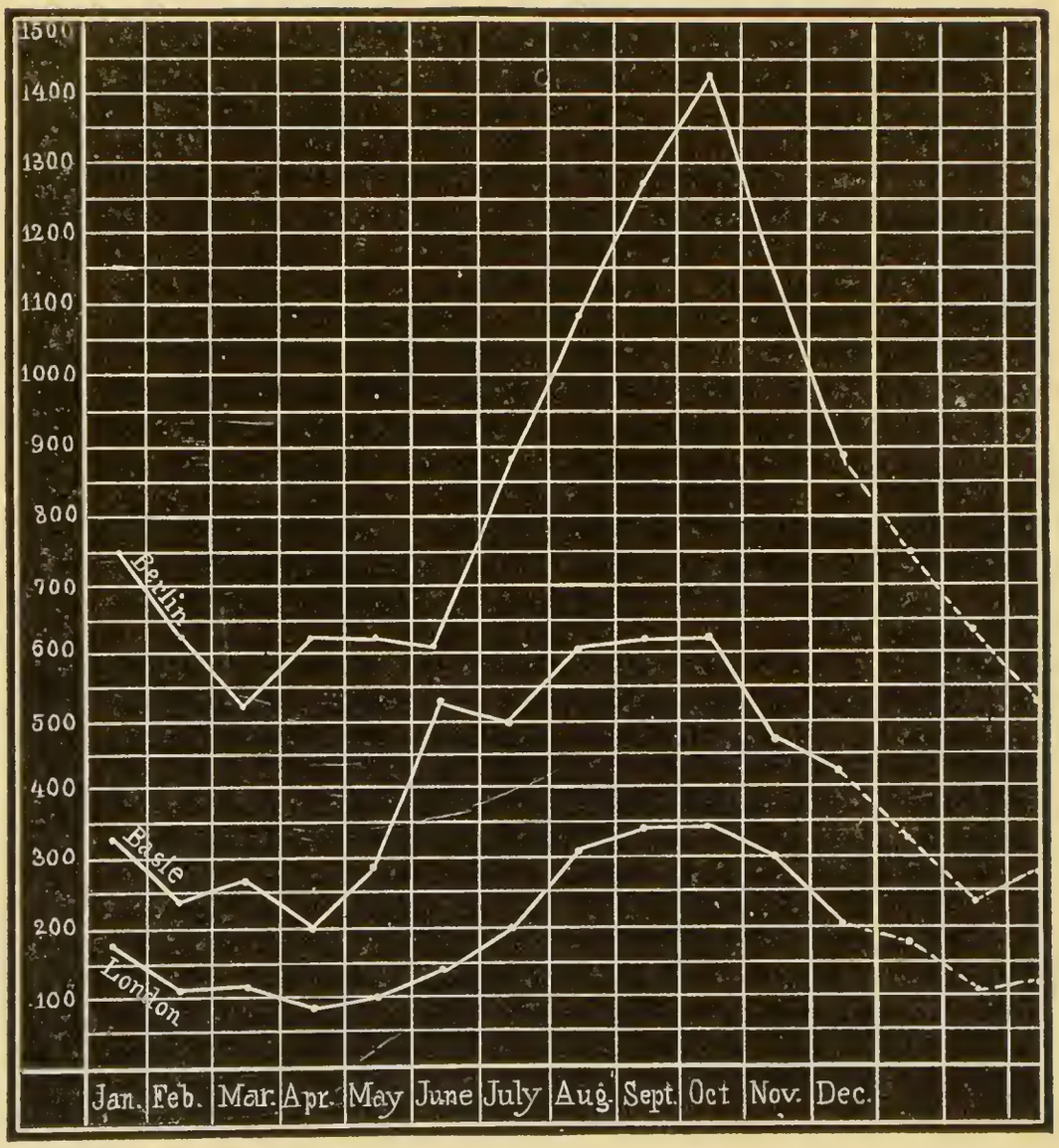
other conditions: whether the region about the source of the spring is inhabited or not; whether the spring is fed from fields or meadows which have been manured; and whether typhoid fever exists among the inhabitants of the region about the spring. The village of Lausen (see page 59) had certainly, in every other respect, a very slight predisposition; but the circumstance that the region about the source of its water-supply was inhabited, and that among these inhabitants typhoid was introduced, was sufficient to produce an enormous epidemic. The city of Basle, also, is supplied by a new aqueduct, into which empties a stream which runs through several villages, disappears beneath the earth, and then appears again to empty into the aqueduct. The sanitary condition of Basle is now likely to be largely influenced by that of these villages (*Haegler*, l. c.). Farther, the arrangement of the privies is of great consequence. The earlier and the more completely human excrements are removed from the neighborhood of dwellings, the less probability is there of the spread of typhoid by privies. Thus, in many English cities, a better system of sewerage has much diminished the number of cases of typhoid fever. In general, we can say that the disposition of any locality to an epidemic of typhoid fever, depends largely upon the extent to which the inhabitants breathe or drink the contents of their privies. The greater the chances of this are, so much the greater are the probabilities that the introduction of an imported case of typhoid will produce an epidemic. Many of our villages are very badly off in this respect. If they escape typhoid for long periods, this depends on their comparative isolation; but if a case of typhoid is once introduced, a severe epidemic is apt to follow.

Among the conditions which exert an influence on the *periodical disposition* of a locality, the seasons are of especial importance. Epidemics of typhoid fever usually occur in the last half of the year. In places where typhoid is endemic, we usually find the disease least frequent from February to April, increasing after June, most frequent from August to November, and again decreasing in December.

The curves in Fig. 1 give examples of the rise and fall of the

frequency of typhoid during the year. They represent the number of cases of the disease occurring in each month, collected from a considerable number of years.

Fig. 1.



Comparative monthly frequency of typhoid fever in Berlin, Basle, and London.

The curves for Berlin represent the fatal cases of "typhoid and nervous fever" which occurred from 1854–1872, in all 10,461 in Fig. 1; the maximum intensity, more particularly, falls in September and October. Still, we find greater or less deviations

cases.[1] The curves for Basle represent the hospital patients of twenty-four years, in all 5,080. Those for London represent the typhoid fever patients in the Fever Hospital for fourteen years, in all 2,432 cases.[2] To compare these curves, we must remember that the Berlin curves represent the time of death of the patients; the Basle and London curves, the time of their reception into the hospitals. Generally speaking, these curves correspond well with each other. The minimum is in February and April (in the Berlin curve a little later), the maximum is in September and October (in Berlin the maximum in October).

The general bearing of these curves is evident. The curves representing the frequency of typhoid correspond to the curves of average temperature, only with this difference: The different points of the typhoid curve follow those of the temperature curve, by an interval of some months. The minimum of temperature falls in January, that of typhoid in February or April; the maximum of temperature falls in July, that of typhoid in September and October. It appears, therefore, that the development and spread of typhoid fever is favored by the high summer temperature and checked by the low winter temperature. The interval of two or three months between the temperature and the typhoid curves corresponds to the time which is necessary for the changes of temperature to penetrate to the places where the typhoid poison is elaborated, for the development of the poison without the human body, for the period of incubation, and for the time between the commencement of the attack and that of the patient's admission to the hospital, or that of his death.

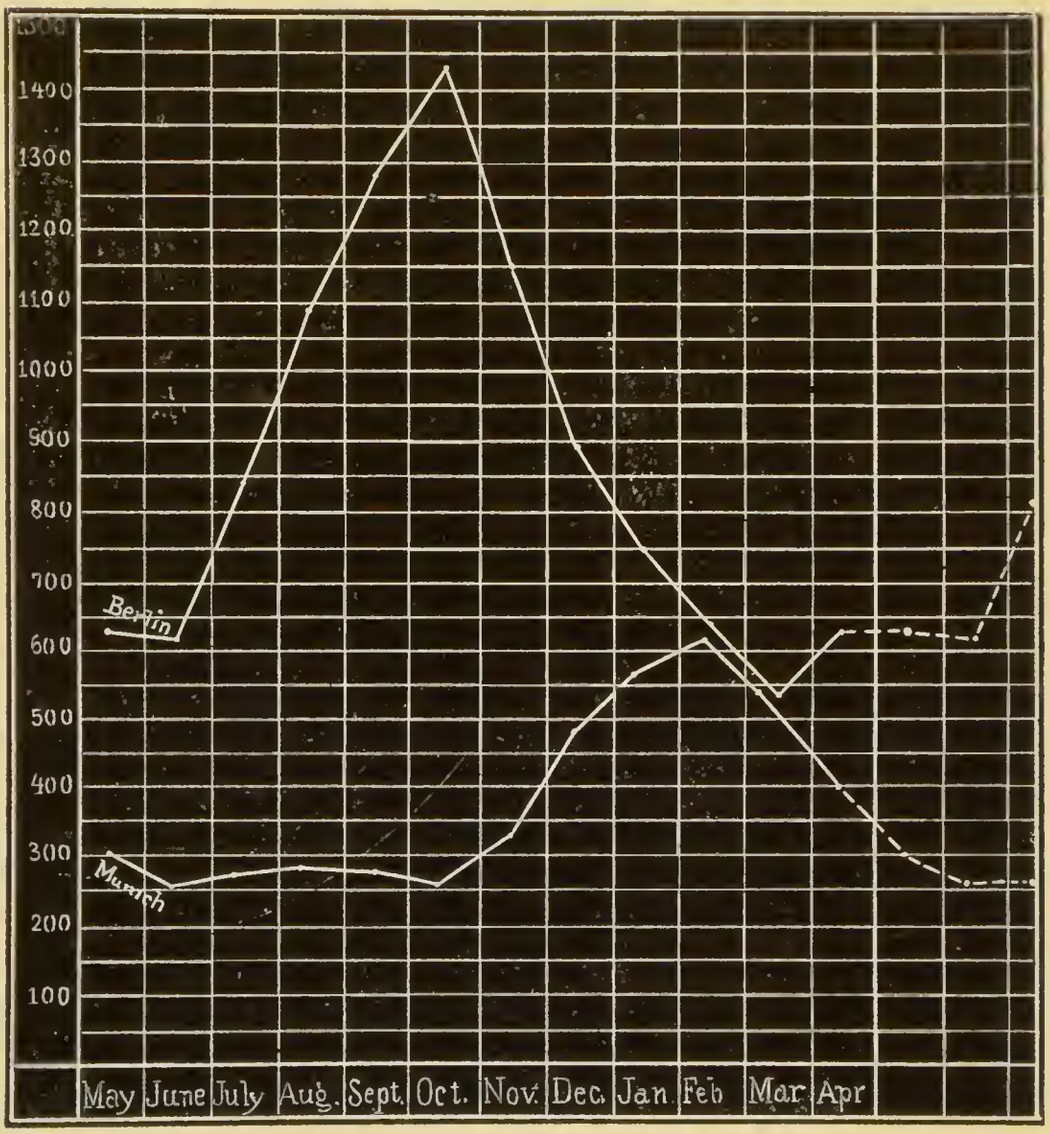
In the separate years the changes in the frequency of typhoid correspond more or less accurately with the curves representing the average of a number of years. In some years the maximum of the disease comes rather earlier; in some, rather later. Generally speaking, the intensity of the disease is greater the later it begins. In many other localities the periodical changes in the amount of the disease correspond with the examples given

[1] *Virchow*, Reinigung und Entwässerung Berlins. Generalbericht über die Arbeiten, etc. Berlin, 1873. Tafel III.

[2] *Murchison*, l. c., p. 417.

from this rule. Thus in Dresden[1] the maximum is earlier in August and September. Munich, however, furnishes the most remarkable exception.

Fig. 2.



Periodical changes in the frequency of the fatal cases of typhoid fever in Berlin and Munich.

In Fig. 2 the monthly changes of the disease in Munich are compared with those in Berlin. The curve for Munich is constructed from the statistics of Wagus, published by Petten-

[1] *S. Fiedler*, Archiv der Heilkunde. 1862. S. 155

kofer, which comprise the years 1851–1867, and include 4,579 cases. To make the comparison easier, we begin with the month of May. According to this comparison the maximum in Munich comes in February, that is, four months later than in Berlin. What does this striking difference indicate? The curve of average temperature differs but little in the two cities. Must we, therefore, assume that, while everywhere else the frequency of typhoid fever is increased by the summer's heat, that in Munich alone it is increased by the winter's cold. No one could assert that in earnest. Out of all possible hypotheses I can only find one at all probable: that in Munich the breeding-places of the typhoid poison lie deeper in the earth than in Berlin and other places. It is known that the temperature of the earth, down to a certain depth, depends upon the temperature of the air, and in a less degree varies with the variations of the latter. But the changes in the temperature of the air are followed by corresponding change in the temperature of the earth more and more slowly the deeper we go beneath the surface. Thus, according to the researches of Forbes, the maximum temperature of the earth, at a depth of four metres, is reached, according to the character of the soil, two to three months later than the maximum surface temperature.[1] If, therefore, in Munich, the localities where the typhoid poison is developed are situated deeper in the earth than at Berlin and other places, it would explain the lateness of the typhoid curve in Munich. There is still another peculiarity in the changes in frequency of typhoid, which exist to a greater degree in Munich than in any other place, and which will be spoken of later. This peculiarity also points to such a situation of the typhoid poison.

The curves marking the periodical changes, although derived from a very large number of cases, do not show a regular rise and fall. Thus the curve for Basle (Fig. 1), besides the principal maximum for August to October, has a lesser maximum for June, whilst in July again a lesser diminution of frequency takes place. It has also two minima in February and April, and

[1] Compare *Pfeifer*, Unters. über den Einfluss der Bodenwärme auf die Verbreitung und den Verlauf der Cholera. Ztschr. f. Biologie. Bd. VII. 1871. S. 263.

between these, in March, lies a third unimportant maximum. A closer consideration of the curves of single years shows that this relation cannot be accidental. The curves for other localities also show indications of the same relations. These facts seem to me to indicate that the epidemics of each year are made up of several successive epidemics, or series of cases, which, however, often become continuous with each other. It is also easily understood how one series of cases may give rise to a second series. The first set of cases multiplies the typhoid poison, the poison accumulates in the privies, undergoes its proper development there, is mixed with the air and drinking-water, and so produces a second series of typhoid cases. In this way the typhoid poison seems to live through several generations in the course of a year.

The periodical disposition in Munich is very strikingly dependent upon changes in the height of the deeper springs of water. The observers in Munich, by establishing this fact, have enriched our knowledge of the etiology of typhoid by a discovery of great promise. Buhl has shown, by comparing the frequency of the fatal typhoid cases in the hospital with the variations in the height of the water, that in Munich, as a rule, while the water steadily rises typhoid decreases, while the water sinks typhoid increases. These statements of Buhl can leave no doubt in any unprejudiced mind. The statistics of Wagus, arranged to show the curves, and published by Pettenkofer, embrace the typhoid mortality of the entire city for a period of twelve years. They completely confirm the formula announced by Buhl. The reports of the medical association of Munich show that the same rule has held good in late years.

Such a relationship between the frequency of typhoid and the height of the water-springs, as exists in Munich, has not as yet been demonstrated for any other locality. But we must remember that only in a few places, and that very recently, have any regular observations of the deep water-shed been made. In Basel neither Rütimeyer[1] nor B. Socin[2] were able to find any

[1] Bericht an das Sanitäts-Collegium von Basel-Stadt über die Brunnenmessungen in Basel, 1865–69. Basel, 1870.

[2] Typhus, Regenmenge und Grundwasser in Basel. Dissertation. Basel, 1871.

such connection, although the statistics employed by the latter extended over a long period. In Basle, the only important factors which seem to exert any important influence on the frequency of typhoid, are the time of year and the temperature of the air. Still, B. Socin, after a careful weighing of all the facts at his command, arrived at the conclusion that in Basle an unusual dryness favors the development of typhoid epidemics, while an increase of moisture is followed by a decrease of the disease. A similar result was repeatedly noted before the time of the Munich observations, for it was found that typhoid fever frequently appears after very hot and dry summers, while it is rare after cold and wet summers and autumns.[1] Virchow found that in Berlin the years in which the rainfall was small were attended with severe epidemic and typhoid affections, while in wet years the mortality from typhoid was small.[2] A similar relation for each separate year was observed in Berlin. The number of typhoid cases rises as the water-level falls; it diminishes as the water-level rises. At the time of the lowest water-level there is every year a small epidemic.[3] It is hardly necessary to remark, that before concluding a connection between typhoid and the water-level in Berlin, we must eliminate the influence of the season of the year upon which typhoid and water-level depend.

However close may be the connection between the frequency of typhoid and the condition of the water-level, we must regret that no satisfactory explanation of this connection has yet been afforded by the Munich observers. A fact is only useful to science when it can be understood. The Munich observers assume that the causes of typhoid lie deep in the earth. When the water-level sinks, the layers of earth, saturated with water and organic substances, which are left exposed to the air, undergo extensive changes of a putrefactive character. When the water rises these layers of earth are again covered, decomposition stops, and the products of previous decomposition are

[1] *S. Murchison*, l. c., p. 419.

[2] *Virchow*, Ueber die Sterblichkeitsverhältnisse Berlins. Vortrag. Berl. klin. Wochenschr. 1872. Nr. 50.

[3] *Virchow*, Reinigung und Entwässerung Berlins. Berlin, 1873. S. 63.

covered over by the water. So far the theory is plausible, and has been accepted by many. And it is true that the circumstance already mentioned, that in Munich the maximum frequency of typhoid comes at a later time than in most other places, has the same significance as does the water-level, namely, that the infecting germs are situated deep in the earth. But even a large production of typhoid poison in the earth can be of no effect unless the poison enters the bodies of human beings, and the difficulty is to explain how the poison does get into the human body. Where wells are used, and the deeper springs are the source of the water-supply, the typhoid germs can be received in that way. But this natural explanation is excluded by the Munich observers, for they deny the agency of drinking-water in producing typhoid. Buhl asserts that drinking-water has no real share in producing the disease, and Pettenkofer declares repeatedly that no one has yet succeeded in showing the influence of drinking-water on the spread of typhoid in Munich. They hold that the typhoid poison passes from the earth into the air, and is inspired into the human body.

Such a theory, however, is beset with many difficulties. It presupposes a series of other assumptions, some of which are not proven, some cannot easily be reconciled with other facts. We have many analogies to show that, if the typhoid poison is contained in matters dried by the air, it can be swept away by every wind, and remain suspended in the air. But to suppose that the poison buried in the earth at the level of the deeper springs can get into the atmosphere, that seems to me an hypothesis to be adopted only when every other possibility is exhausted. There is, indeed, no doubt that gases can arise from the earth into the atmosphere, and that in houses which are heated in winter the warmth produces an ascending current of air.[1] But the typhoid poison is not a gas, and it must appear very doubtful whether solid particles can be drawn from such depths in sufficient quantities to render the air infectious. The principal reason, however, against the theory that the typhoid

[1] *Pettenkofer*, Ueber die Luft im Boden oder Grundluft. Drei Vorlesungen, gehalten in Dresden. 3. Vorl. Braunschweig, 1863.

poison is contained in the exhalations from the ground, and thus diffused throughout a typhoid locality, is this: that the larger epidemics are composed of smaller epidemics and endemics; that particular foci of infection can be demonstrated which are confined to groups of houses, or even single houses. A more exact study of the way in which typhoid is propagated shows that the infection is diffused from individual privies and dunghills, and secondarily from individual springs. It is only in the immediate neighborhood of masses of decomposing matter that the typhoid poison exists in the air in sufficient quantities to produce infection. A man who avoids breathing the exhalations of privies and sewers, who does not handle linen foul with typhoid dejections, who does not drink unboiled water from infected springs, is as safe in a place where a typhoid epidemic is raging as in one where not a case of the disease exists. The typhoid poison is not acquired in the streets, nor in houses of which the privies are not infected.

After becoming acquainted with Buhl's discovery of the connection between the frequency of typhoid and the water-level, I endeavored to find some other explanation of the facts.[1] We find a simpler explanation of Buhl's results if we go back to the original facts. The water-level was determined by measuring the water in the springs. Thus the result found by Buhl more exactly stated would be: When the water rises in the springs the frequency of typhoid diminishes, when the water falls typhoid becomes more frequent. A more striking proof of the influence of drinking-water on typhoid fever could hardly be afforded. It is evident, and a matter of ordinary experience, that, *cæteris paribus*, the water of any spring is purer the higher it is. The lower the water is, the greater must be the relative proportion of solid matters dissolved or suspended in it. In localities where typhoid fever is endemic, where the specific cause is in the earth, or constantly soaking from the privies into the earth, this poison must be relatively more abundant in the water the lower the latter is. Much also of the matter which drains from the surface into springs is washed away when the

[1] Deutsche Klinik, 1866. Nr. 10.

latter are high, before it can settle to the bottom. When the water is low, such matters sink at once to the bottom of the springs, from whence they are again drawn to the surface. Buchanan,[1] one of the most experienced observers in this department, has since given a similar explanation of the connection between the frequency of typhoid and the water-level. If this explanation is correct, we should find, as Buchanan also remarks, a connection between the water-level and the amount of typhoid only in those localities where the inhabitants draw their water-supply from wells. That this condition can be fulfilled, even where there are aqueducts besides the wells, I found by a careful inquiry in Basle. I found that in that city, notwithstanding the abundant supply of running water, the greater number of the inhabitants habitually used well-water for drinking purposes.[2] And in the same way for other localities, the important question is not, what is the water-supply, but what water do the inhabitants really drink.

I recognize the difficulties which may lie in the way of the application of this theory to the Munich observations. The greatest of these difficulties is that in Munich no connection between typhoid and the drinking-water has yet been shown. An exact study of these relations can only be made by observers who live on the spot, and I cannot renounce the hope that, when once these observers shall have given up the dogma that infection cannot be produced by drinking-water, and resume their researches with an unprejudiced mind, new light will be thrown on the facts.

Of the conditions which determine the *individual disposition*, age is the most important. According to all experience, the greatest predisposition is between the ages of fifteen and thirty years; it diminishes in proportion to the distance of the age from these limits. Children less than a year old are very seldom attacked; after this, up to fifteen years old, the predisposition steadily increases. The following table will serve to show the predisposition for different ages after fifteen years. It gives

[1] Deutsche Vierteljahrsschrift für öffentliche Gesundheitspflege. 1870.

[2] Deutsche Klinik. 1866. Nr. 10.

the typhoid patients in the hospital at Basle, from 1865–1870, divided into classes according to their ages. As a rule, persons under fifteen years of age are not admitted to the hospital, so that the few cases of this age are not counted. The simple numbers, as they are given in column I., do not give a true picture of the predisposition for the different ages; for if we class the entire population according to age, we find the number of persons belonging to each class to be different. Therefore, under II. is given the percentage of typhoid cases for each class, and under III., the percentage of the entire population which the number of persons belonging to each age represents, according to the census of 1870, but omitting all those below fifteen years. The comparison of columns II. and III., therefore, gives a true representation of the predisposition of each age. In IV. this is shown by giving the quotients produced by dividing the percentages in column II. by those in column III. If we compare these figures with the average number of cases which would exist if the typhoid cases occurred in the same proportion at all ages, we find that from 16–20 years, $1\frac{1}{2}$ times as many cases occur; from 21–30, twice as many cases; in the 4th decennium, only $\frac{2}{3}$ as many; in the 5th, only $\frac{1}{3}$; in the 6th, $\frac{1}{5}$, and after the 6th, only $\frac{1}{10} - \frac{1}{50}$.

Age.	I. Number of typhoid patients.	II. Percentage of all the typhoid cases.	III. Percentage of persons of each age in the entire population.	IV. Disposition compared to the average = 1.
16–20 years	323	19	12	1.6
21–30 "	987	58	29	2.0
31–40 "	274	16	24	0.7
41–50 "	88	5	16	0.3
51–60 "	30	2	10	0.2
61–70 "	11	0.6	6	0.1
71 and over	1	0.06	3	0.02

According to Murchison's statistics more than half (52 per cent.) of the cases brought into the hospitals were in persons from 15–25 years old. In the city hospital of Dresden, 81 per cent. of all the typhoid patients were from 16–30 years old. (*Fiedler*, Archiv der Heilkunde, 1862. S. 164.)

As regards sex, as a rule, decidedly more men than women are attacked, although some statistics show a predisposition of the two sexes very nearly equal.

The preponderance of typhoid among males, shown by the statistics of most hospitals, is not to be considered by itself as a proof that men are really more often attacked, for in most places more men than women seek hospital treatment. In the hospital at Basle, including the temporary hospital, from 1865–1870, there were treated 1,297 male and 751 female typhoid patients, that is, 63.3 per cent. males and 36.7 per cent. females. Of patients suffering from other diseases in the same hospital, in 1869 and 1870, 52 per cent. were males and 48 per cent. females. Typhoid fever, therefore, was more frequent in the male sex.

According to Fiedler, there were in Dresden 862 male and 635 female typhoid patients, that is 57.6 per cent. males and 42.4 per cent. females. Of all the hospital patients, 51.4 per cent. were males, 48.6 per cent. females. According to Murchison, there were in the London Fever Hospital, out of 2,432 typhoid patients, 1,211 males and 1,221 females, almost an equal number.

It is a fact which can everywhere be demonstrated that typhoid, in contrast with many other diseases, and especially with cholera, attacks, by preference, strong and healthy persons, while it avoids those already suffering with chronic ailments. Pregnant and puerperal women also, and those who are nursing infants, are seldom attacked with typhoid. In all these respects, however, the immunity is only relative, in severe epidemics exceptions are frequent; of these we shall have more to say when we consider the influence of the individual relations on the course of the disease.

The immunity of pregnant and puerperal women, in localities where severe epidemics prevail, is not so great as has often been assumed. Thus, in the hospital at Basle, out of 1,400 typhoid patients over 15 years old, there were 48 pregnant women, and 7 who had been confined within 10 weeks. In Basle, with a total population of 33,000 people over 15 years old, there are a little more than 1,400 births yearly. There are, therefore, if we reckon the duration of pregnancy and the period after confinement together at a little less than one year, always about 1,400 individuals in this condition, that is, 1 to every 24 inhabitants over 15 years old. Among the typhoid patients the proportion was 1 to 56. But if we consider that pregnant and puerperal women, if they are taken sick, are not as apt to seek hospital treatment, we will see that their immunity is even less than indicated by these figures. (Compare *Hecker*, Monatschrift f. Geburtskunde. Bd. XXVII. S. 423.)

The disease itself confers a certain immunity upon an individual who has once passed through it, but not as complete as is the case with variola, measles, and scarlatina. In the Basle hospital, patients were sometimes received who had previously passed through the disease, but they were relatively few in number. Lindwurm (l. c.), also, mentions cases of several successive attacks in the same person. Persons who have lived for a long while in a typhoid locality are less apt to be attacked than strangers who have recently arrived.

Real recurrences, that is, a new attack coming on soon after the first has run its course, and relapses before the completion of the disease, are often seen. We will speak of them when we consider the sequelæ.

Whether animals can suffer from real typhoid fever is not definitely determined. At all events, most of the epidemics among domestic animals, which have been called typhoid fever, are not identical with the typhoid of man. We must take care not to conclude the identity of the causes from a similarity in the lesions. Very lately an attempt has been made by Birch-Hirschfeld[1] to infect rabbits with typhoid fever. The results are such as to invite farther experiment.

The opinion of many of the older physicians that "Nervous Fever" could be produced by severe mental disturbance, by fear, sorrow, or care, has been long abandoned, and the idea that excessive exertion, exposure to cold, or improper food can produce typhoid fever, is also given up. For us the cause of typhoid fever is always a specific poison; if this poison is not received into the body, anything else may be produced, but no typhoid fever. But it would be going too far to deny the facts on which these ideas of the older physicians rest. All these conditions can, under circumstances, act as accidental causes. In a person already infected with typhoid poison they may bring on the attack. Many circumstances seem to show that both in this and in other diseases the period of incubation may be influenced by special causes.[2] These accidental causes appear sometimes

[1] Naturforscherversammlung zu Wiesbaden, 1873. Allg. Zeitschr. für Epidemiologie. Heft 1.

[2] Compare *Gerhardt*, Deutsches Archiv f. klin Me l. Bd. XII. 1873. S. 1.

to play a more important part. It is probable, and seems to be confirmed by experience, that they may assist in increasing the predisposition of the individual for the disease by inviting the reception of the poison and its development in the body. As in cholera, so, perhaps, in typhoid fever, a fault in diet or an exposure to cold, may cause many a person to become sick, by whom, without these accidental causes, the poison would not have been acquired.

The diseases which are produced by the specific poison of typhoid fever differ a good deal among themselves. Some of these diseases are so serious that life is almost inevitably destroyed by them; others are so trifling that patient and physician are left in doubt whether there were really any disease at all. And between these extremes we find every gradation, together with manifold modifications and combinations. Thus some cases, at first trifling, will terminate fatally; other cases begin severely and yet go on lightly, and end in cure; others again will be attended with such important complications that, in comparison, the original disease seems of little account. So long as the classification of disease was chiefly based on the symptoms, it was impossible to recognize the relationship between these manifold forms of disease. But even now the lightest cases are often called not typhoid fever, but afebrile or febrile abdominal catarrh, gastric fever, etc., a custom which is practically not unjustifiable.

If we should undertake to give a picture of typhoid fever which would be true of all its varieties, we would meet with insurmountable obstacles. We are compelled to take account of the numerous varieties which exist, and to consider the different forms which the disease assumes, separately.

We will, therefore, consider, first, the typical cases, those usually called severe or average cases of typhoid fever. We will treat first of the symptoms, then of the regular lesions, and will then attempt to give a general view of the course of the disease, tracing as far as possible the connection between lesions

and symptoms. To this representation of the typical, well-developed cases will be added an account of the undeveloped cases. Remarks will then follow concerning the diagnosis, the results, the prognosis, and the individual relations which affect the course of the disease. Finally, we will treat of the complications and sequelæ.

REGULAR CASES OF TYPHOID FEVER.

SYMPTOMATOLOGY.

Wunderlich, l. c.—*Murchison*, l. c.—*Griesinger*, l. c.—*F. Niemeyer*, Lehrbuch. Bd. II.

Among all the symptoms of typhoid fever the febrile movement is the one which most attracts attention, and is the most important in determining the diagnosis, prognosis, and treatment. "The fever in great measure controls the situation" (Griesinger). Since the course of the fever corresponds in general to the course of the primary lesions, and since the symptoms and secondary lesions are, in great part, only results of the fever, it will be the best plan first to describe the course of the fever. Before we take a general view of the disease, therefore, we will give a more exact account of the fever and its immediate consequences.

In typhoid fever the febrile movement has, as has been determined by the extensive observations of Wunderlich,[1] a typical and cyclical course. To each separate period corresponds a certain degree of fever, and the separate periods are so far limited that, in uncomplicated cases, they do not exceed a certain duration. The diagnosis of typhoid fever can usually be made from the fever curve alone, and this is true not only of the simple cases, but also of the obscure and complicated ones, provided that the physician is acquainted with the ordinary deviations. It is unnecessary to say that it is not for this reason at all wise

[1] *Wunderlich*, l. c.—Compare also: Das Verhalten der Eigenwärme in Krankheiten (Leipzig, 1868; 1 Aufl. 1870), also numerous articles in the Arch. f. physiologische Heilkunde und Archiv der Heilkunde.

in practice to neglect the other symptoms and only notice the fever.

In the well-marked simple cases the entire duration of the fever is from three to four weeks. For the schematic representation we can distinguish four periods, to each of which belongs a characteristic degree of fever, and each of which lasts about a week. This typical course of the fever, however, may be modified in many ways, both by complications and by the use of remedies, and sequelæ may prolong it indefinitely. But even in the uncomplicated and untreated cases the four periods often do not have the duration of exactly a week. We must understand that when we speak generally of the first, second, or third week of the disease, we mean periods varying from five to nine days.

The course of the fever in these four periods may be thus characterized (see the schematic representation on p. 79, Fig. 3):

In the first week there is a gradual and steady increase of the fever.

In the second week the fever is continuous.

In the third week the fever begins gradually to be remittent, whilst it reaches the same degree at its exacerbations.

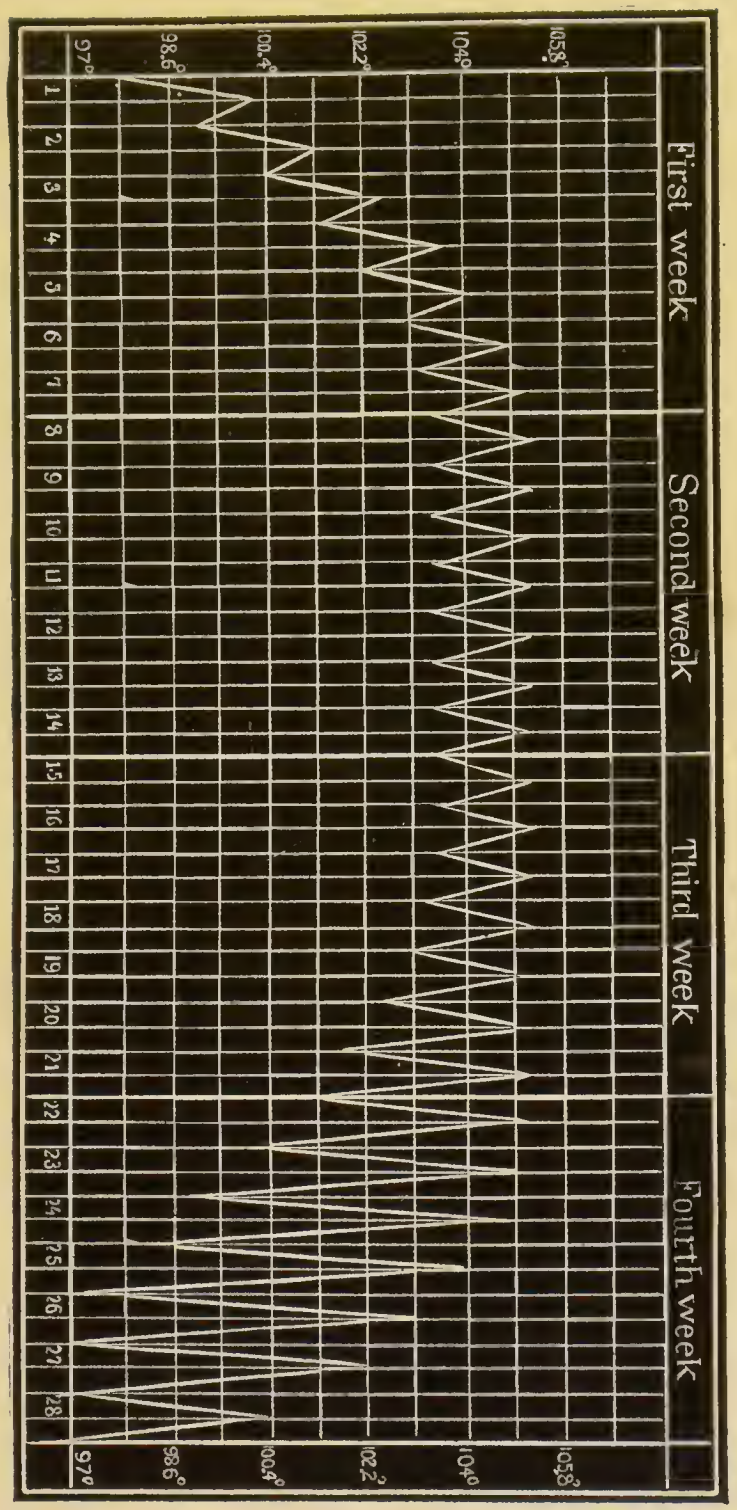
In the fourth week the fever becomes intermittent, and the exacerbations gradually lower.

In order to bring this scheme into accordance with common language, some additional remarks are necessary.

When we call the fever in the second week continuous, we do not mean that the temperature remains constantly the same. According to our schematic representation of the fever the temperature is lower in the morning, higher in the evening, and for this reason many authors speak at this period of a remittent or subcontinuous fever. But if we are to define a continuous fever to be one in which the temperature is the same through the day, there would be no such thing as a continuous fever. But in reality the fever of the second week of typhoid fever is the type of that which the older physicians designated as febris continua. We may define continuous fever to be a fever in which only the normal diurnal variations and no remissions occur. In fact, as was pointed out by Jürgensen,[1] the variations in tem

[1] Die Körperwärme des gesunden Menschen. Leipzig, 1873.

Fig. 3.



Schematic representation of the course of the fever. The lowest morning and highest evening temperatures are given and joined by straight lines. Fahrenheit's scale.

perature which occur in such a fever are identical with the variations which occur in the twenty-four hours in health. The causes of the higher evening and lower morning temperature in typhoid patients are the same as those which produce these variations in healthy persons. These causes are dependent on the ordinary relations and conditions of the twenty-four hours in connection with daily habits.

A similar explanation is necessary in regard to the first week. Our assertion, that during that period the fever gradually and steadily increases, is only correct when we take into account the continuance of the normal diurnal variations. In fact, if we reflect that, in the first seven days of the disease, the average temperature rises from 98.6° to more than 104°, and if we suppose that on either side of this average increasing curve of temperature the normal daily variations take place, we will find curves the same as those given in the scheme for the first week of typhoid.[1] It is to be remarked in addition, that in many cases the increase takes place more rapidly than is given in our scheme, so that the maximum temperature is reached on the fifth day, or even earlier.

The daily temperature curve of typhoid fever, corresponding to the changes occurring in each twenty-four hours, has been principally made known to us by the researches of Thomas, Jürgensen, and Immermann.[2] The curve of typhoid fever, like that of health, shows a minimum, which occurs most often early in the morning between six and eight o'clock, and a maximum usually at about six in the evening. But as in many healthy persons there are other regular variations, besides those in the morning and evening, apparently dependent upon individual conditions and habits, so in typhoid fever the curves may show more than one daily maximum. Curves with two maximum points are, according to Immermann's observations, almost as frequent as the curves with a single maximum. In such curves, besides the maximum at six in the evening, there is another maximum at the middle of the day, usually of less intensity. The curves with several maxima are less frequent. Both Thomas and Immermann are disposed to deduce the special form of the daily curves from individual conditions; and with this agrees the experience that one patient will have exclusively curves with one maximum, another, curves with two

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[1] Compare *Jürgensen*, l. c.

[2] *Thomas.* Arch. der Heilkunde. 1864. S. 431.—*Ziemssen* und *Immermann*, Die Kaltwasserbehandlung des Typhus abdominalis. Leipzig, 1870. S. 26.—*Jürgensen*, l. c. —Compare *Leichtenstern*, Ueber Abdominaltyphus. München, 1871.

maxima, another, curves with several maxima. But in the same patient there may be a change in this respect, especially in the later stages of the disease, a change to more simple curves. Towards the end of the third week, whilst the difference between the maximum and minimum becomes greater, the periods of exacerbation become shorter. Sometimes also the falling of the temperature during the night is not steady, but after midnight there is a slight temporary elevation of temperature. The regular type of daily rise and fall in typhoid fever, as in health, is that the temperature rises during the day and sinks during the night.

During the purely continuous stage of the fever, the difference between the maximum and minimum in most cases is only a little less than is the case in healthy persons, who are in perfect quiet; it averages about one and a half degrees.

Only in cases in which the fever is very severe, and the absolute temperature very high, the difference is less, and does not exceed three-fourths of a degree. One would suppose *à priori* that such a departure from the normal variations of temperature points to a more severe form of disease, and we do find that in such cases the fever is peculiarly severe and obstinate. On the other hand, greater variations in temperature, especially remissions in the morning, at an early stage of the disease, denote a probable light degree of disease.

Smaller deviations from the schematic course of temperature, such as smaller rise of temperature in the second week, or a single more marked remission at the end of the first week, or the middle of the second, are of frequent occurrence, but do not appear to belong to any peculiar type. More marked deviations are always due to special causes, and it is the physician's duty in each case to inquire what these causes are. Often in this way something is discovered, which, except for the abnormal temperature, would have been overlooked. But in many cases we are not able to discover what these causes are.

The great practical importance of the determination of the temperature is more evident in typhoid fever than in any other febrile disease. It may well be asserted that a rational treatment of typhoid fever, without following the temperature, is not possible; and that any physician who does not make two or more observations of the temperature every day, neglects his duty. The common remark, that such observations are applicable to hospital, but not to private practice, has been found to be erroneous. To measure the temperature in the rectum, or even in the axilla, requires so little time that a physician who does not have the requisite leisure, can hardly treat such a patient at all. Besides this, nurses sufficiently intelligent to use the thermometer are requisite for any proper treatment of these patients. A physician can really treat his patient better if he only sees him once a day, but has a good thermometrical record kept by the nurse, than if he makes several visits and does

not employ the thermometer. The use of the thermometer in private practice, showing as it does to unprofessional persons the importance of the rise and fall of temperature and the effect of treatment on the fever, has more than anything else narrowed the field of homœopaths and charlatans.

After representing the course of the fever, we consider, next, the symptoms which are the *immediate result of the increase of temperature.*

A careful observation of the *heart's action* during the course of typhoid fever is of the greatest importance. We judge of this partly from the pulse, partly from other conditions.

The *frequency of the pulse* depends in typhoid fever, as in all other febrile diseases,[1] immediately and principally on the degree of temperature. Its average course, as we learn from a large number of cases, runs parallel to that of the temperature. The pulse becomes gradually more frequent in the first week, remains at its height in the second and third week, and in the fourth week sinks again to the normal average. The daily variations in the pulse also correspond with those of the temperature; the pulse is less frequent in the morning than in the evening.

The absolute height of the frequency of the pulse is less in typhoid fever than in most other febrile diseases. There are even some cases in which the pulse, during part of the time, does not become more rapid, although the temperature is increased. This fact was noticed and was considered an assistance in diagnosis by the older physicians (Sauvages, Hufeland, Berndt). So long as the heart's action remains vigorous, the pulse does not usually rise above 110, and in many cases it will not rise above 100 during the entire course of the disease.

For the present we can hardly decide whether this comparative slowness of the pulse in typhoid fever is due to the slow increase of temperature, or whether the infection with the typhoid poison has a depressing influence on the pulse. The last assumption is rendered more probable by the fact that in the lightest febrile and afebrile forms of typhoid infection the pulse may be for a long while less frequent than the normal.

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[1] Compare my Statistics of Temperature and Pulse. Deutsches Arch. f. klin. Med. Bd. I. 1866. S. 461.

The frequency of the pulse in typhoid patients may be increased for a short time by accidental causes. Thus, simply lifting the patient in bed may increase the pulse to 120 or more.

If the continuous stage of the fever lasts longer than usual, and the heart's action becomes weaker, the pulse becomes more frequent, sometimes even reaches the utmost possible frequency. If in an adult the pulse rises, without any special cause, to 120, and remains for some time at that point, the prognosis is usually bad. It indicates, usually, the commencement of a paralysis of the heart, which will soon kill the patient. In these cases the quality of the pulse also shows how feeble the heart's action is.

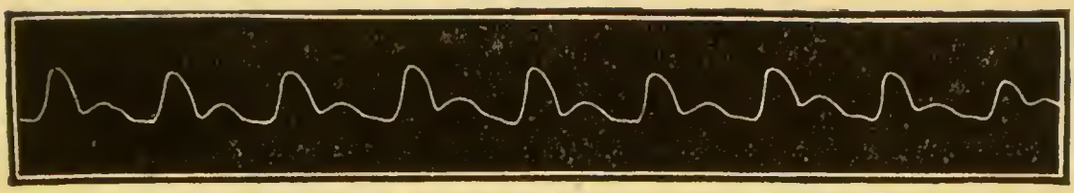
In regard to the *quality of the pulse*, it is to be noticed that usually, after some duration of the fever, the artery feels relaxed and soft, easily compressible, and the dicrotism of the pulse can be appreciated with the finger. It has often happened to me that when the dicrotism was very striking, the nurse has counted twice as many pulse beats as there really were. So long as the heart's action is still strong, the pulse wave expands the artery markedly, on account of the relaxation of the arterial wall. The weaker the heart becomes, so much the smaller and weaker becomes the pulse, until at last it can hardly be felt. When the weakness of the heart is far advanced the pulse is often irregular, and sometimes even becomes less frequent without any increase in the force of the heart's action. The greater number of the patients who die without complications at the height of the disease, die from weakness or paralysis of the heart.

In the hospital at Basle the sphygmograph was used in numerous cases. Dr. Fischer-Dietschy, especially, studied in this way the relations of the pulse in typhoid fever and other diseases, and directed particular attention to the value of the pulse curve in prognosis. Out of a number of curves kindly given to me by Dr. Fischer-Dietschy, I reproduce a few on the following page, to illustrate the relation of the pulse in the different periods.

When the heart's action is very feeble, the *diminution of the circulation* is shown by other disturbances. The congestion of the veins produces a certain degree of cyanosis, the incomplete filling of the arteries is followed by a diminished secretion of urine. Hypostases make their appearance, especially in the

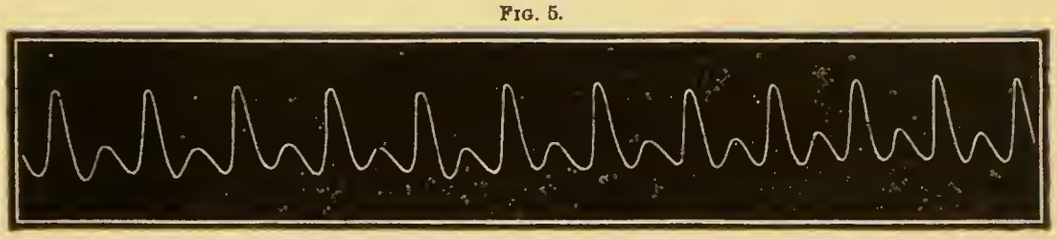
lower parts of the lungs. In the most marked degree of weakness of the heart death may be produced by general œdema of the lungs. Many other complications, which will be treated of later, have their origin in the weakness of the heart.

FIG. 4.



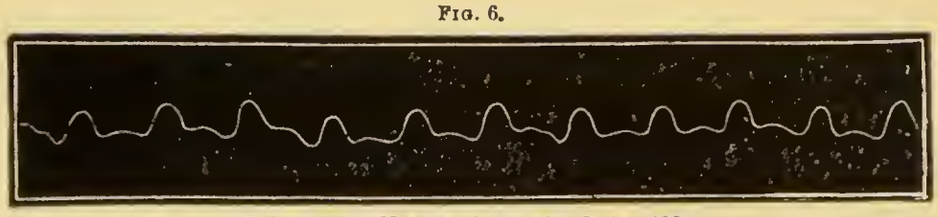
Pulse curve at the end of the first week. Strong heart action, moderate dicrotism. Frequency, 104.

FIG. 5.



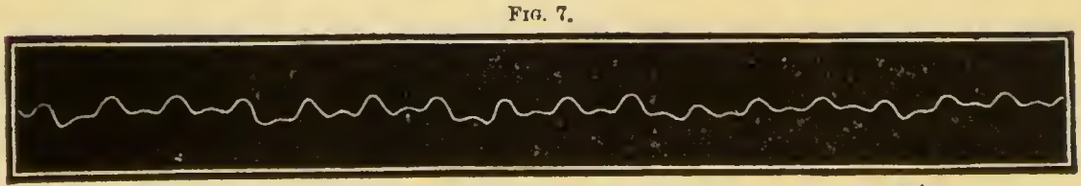
Third week. Strong heart action, strong dicrotism. Pulse, 108.

FIG. 6.



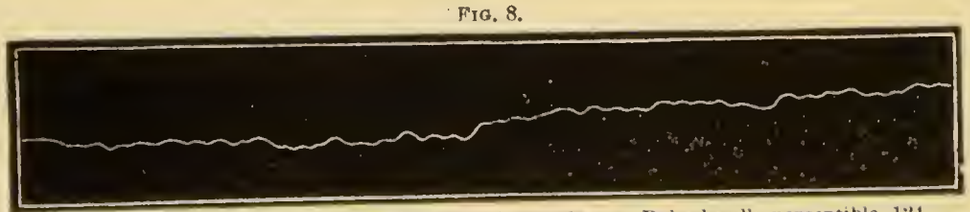
Third week. Heart action weak. Pulse, 128.

FIG. 7.



Beginning of paralysis of the heart. Pulse, 144. Figs. 4 and 5 from the same patient.

FIG. 8.



Paralysis of the heart after profuse intestinal hemorrhage. Pulse hardly perceptible, 124.

The *temperature of the peripheric portions of the body*, and its relation to that of the viscera, is of special importance in judging of the condition of the heart's action. The more the heart's action and the circulation diminish, so much the greater

is the difference between the peripheric and inner portions of the body. The peripheric portions continue, as usual, to lose heat, and this heat is no longer replaced, as in the normal condition, by a sufficient stream of warm blood. For this reason marked coldness of the hands and feet, the face and the nose, while the internal temperature is high, is a very bad sign, as it shows how very weak the heart's action is. This coldness of the extremities from diminished circulation is, however, not a bad sign when it is only produced by a chill, such as is sometimes caused in typhoid fever by some of its complications.[1]

Here belong also those conditions which are usually called *collapse*, and which depend essentially upon sudden weakness of the heart's action. In typhoid fever collapse can occur in many ways, more easily in proportion to the heart's weakness. It can, for example, result from a profuse hemorrhage, or from the shock produced by perforation of the intestine, or some other severe internal lesion. But even a sudden diarrhœa or violent vomiting may produce collapse. A sudden sinking of the temperature, either spontaneous or produced by remedies, may, by withdrawing from the heart the stimulus of a high temperature, cause sudden weakness of the heart and collapse. We must also mention the collapse which occurs in patients, in convalescents, and sometimes in healthy persons, who suddenly change from a recumbent to an erect posture, and thus induce momentary anæmia of the brain. Sometimes a condition resembling collapse is seen to follow a cold bath. This depends not always on weakness of the heart, but in part on the direct cooling of the periphery, in part on the arterial contraction produced by the cold.

Collapse is, under all circumstances, an important occurrence, for the momentary weakness of the heart may pass into complete paralysis and quickly cause death. Generally speaking, the importance varies with the different causes and conditions. Thus, the collapse which depends on a sudden decrease of fever, the "Collapsus of Defervescence," is generally without

[1] The prognostic value of these conditions was known to the ancients. This can be seen from many passages of the Hippocratic writings, where, it is said, that in non-intermittent fevers, if the outer parts are cold and the inner hot, the prognosis is fatal.

danger, and may even be a favorable sign; while the collapse which is caused by continued weakness of the heart, especially when the internal temperature remains high, is very dangerous.[1]

Another series of symptoms which, in my opinion, are directly produced by the increased temperature, are those caused by *disturbances in the functions of the nervous system.* That these disturbances are results of the increased temperature is shown both from the facts which I have related elsewhere,[2] and by the circumstance that an energetic cooling treatment will prevent or diminish these nervous or typhoid symptoms. In the hospital at Basle, since the antipyretic treatment has been consistently carried out, although the typhoid patients averaged more than thirty, I have but seldom been able to show at the clinique a good example of the status typhosus. I was obliged for this purpose to use patients who had not been brought into the hospital until the disease was far advanced, and even in these patients the nervous symptoms were much ameliorated by the antipyretic treatment.

But although we consider the severe brain symptoms to be the results of the increased temperature, this is only true within certain limits. The typhoid infection of itself, and without the influence of increased temperature, effects a certain disturbance of the mental and bodily functions. Disturbances of this class, not the results of temperature, are seen at the outset of the disease, and also in the less severe febrile and afebrile cases. Such disturbances are seen in a general malaise, a bodily and mental weariness, an unwillingness to work, in headache, vertigo, sleeplessness, etc.

The nervous disturbances due to increase of temperature are essentially the same as occur from the same cause in other febrile diseases. The only reason for their peculiar character in typhoid fever is, that in consequence of the gradual increase of the temperature, and the long duration of the fever, the entire series of symptoms is more fully developed than in most other diseases.

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[1] Compare *Thierfelder*, Arch. f. physiologische Heilkunde. 1855. S. 203.— *Wunderlich*, Archiv der Heilkunde. 1861. S. 289. Eigenwärme in Krankheiten. 2 Aufl. S. 173.

[2] Deutsches Arch. f. klin. Med. Bd. I. 1866. S. 543.

We may distinguish[1] four different degrees in these febrile disturbances of the nervous system, which usually occur successively in severe cases of typhoid fever. In the *first degree* there is no disturbance of the intellect, and the symptoms cannot be clearly distinguished from those due to the typhoid infection alone, without increase of temperature. There is general malaise, restlessness, headache, unfitness for mental occupation, unquiet sleep disturbed by dreams. This class of symptoms corresponds to the first half of the first week. In the *second degree* there are already temporary disturbances of the intellect. The patient is somewhat apathetic, his sensations are blunted, and his memory fails. When half awake, and when not thinking of himself, he becomes delirious ; but as soon as he collects himself his mind is clear. This class of symptoms belongs to the second half of the first week and the beginning of the second. The *third degree* is characterized by a continued disturbance of consciousness, although the patient can sometimes be roused for a little time. There is muttering delirium, a drowsy condition, or even sound sleep, from which the patient can be temporarily aroused and even excited to exercise his volition. In other cases the delirium is more violent, with great restlessness, sometimes with periods of great excitement. The symptoms of the third class begin in the severe, untreated cases, in the course of the second week, and continue, sometimes increasing up to the fourth degree, into the fourth week. In the *fourth degree* there is constant loss of consciousness, from which the patients can no longer be aroused. They lie without any evidence of mental activity, do not react when spoken to or shaken ; at the most, if a very tender place is touched, the face contracts and the patient groans. This highest degree is developed, in the worst cases, gradually from the disturbances of the third degree, and begins usually in the third week, in protracted cases somewhat later, only in the very worst cases earlier.

The disturbances of the third degree represent the complex of symptoms which is even yet called the *status typhosus*. To this same state are referred the dry and cracked tongue and lips, and the sordes. The quiet delirium of the third degree and the drowsiness, as well as the fourth degree of symptoms, correspond to the

[1] Compare Deutsches Arch. f. klin. Medicin. Bd. I. 1866. S. 543.

febris nervosa s. torpida of authors. The more violent delirium corresponds to the *febris nervosa erethistica* and *versatilis*. The ancients comprised the symptoms of the third grade under the name of *phrenitis*, and sometimes distinguished the more stupid conditions as *typhomania*, or *coma vigil* (Κῶμα ἀγρυπνον).[1] The symptoms of the fourth degree correspond to the *lethargus* of the ancients, to whom it was well known that lethargus was often developed from phrenitis.

The disturbances of the highest degree correspond to an almost complete abolition of the functions of the cerebrum; and when this paralysis extends to the medulla oblongata it leads to death. Otherwise death from simple brain paralysis is not frequent; usually symptoms of heart paralysis complicate the case. Cases of the utmost prostration of the brain's functions are not desperate so long as no symptoms of heart paralysis exist. This fact agrees with other experiences, which show that temporary abolition of the functions of the brain is not nearly so dangerous to life as abolition of the functions of the heart.

It is important to notice, in order to judge truly of the degree of mental disturbance in each case, that those symptoms are not always the most severe which make the greatest impression on the laity. Thus, under certain circumstances, furious delirium is not so bad as a certain degree of drowsiness or coma. To judge properly the degree of disturbance often requires more than a superficial observation. The less apparent and more negative disturbances, the simple weakening or abolition of functions, are often of graver import than those perverse actions of functions which are so striking. There are typhoid patients who lie in bed apathetically, apparently almost sensible, answering the daily questions correctly, and showing for some things good memory and judgment. But if we go farther and ask how long they have been sick, what time it is, or what is the day of the week, month, or year, we will find that the mental functions are really seriously impaired.

As the fever decreases, so does the mental condition usually improve. But it is a long while before the mind is restored to its normal standard, and patients who have passed through a severe typhoid fever often suffer for months from want of

[1] Compare *Galen*, De comate secundum Hippocratem. Ed. Kühn. VIII., p. 643.

memory or from some other evidence of psychical weakness. This fact does not appear extraordinary when we remember that the continued high temperature produces material changes in the central nervous organs, from which recovery must be slow.

In giving a *general view of the disease*, we could follow the example of the older authors and distinguish, besides a stadium prodromorum, a stadium incrementi, corresponding to the first week, a stadium acmes embracing the second week and part of the third, and a stadium decrementi, beginning at the end of the third week. Or one can follow later authors and divide the disease into two periods, of which the first embraces the development of the disease, the second includes the period of improvement and convalescence. The first three weeks of the disease would fall within the first of these periods, the fourth week and the period of convalescence within the second. It appears, however, more convenient to retain the division into weeks, which we employed in following the course of the fever. We will describe a severe case, treated on the expectant plan, without complications, and with a favorable termination.

A *stadium prodromorum* usually precedes the outbreak of the disease. This stage has nothing characteristic in its symptoms, but lasts longer than in almost any other acute disease. The patients have a general feeling of malaise, weariness, pains in the limbs, are silent and indolent; the muscles are relaxed, the countenance is dull, the appetite is diminished, the tongue is swollen and coated. Sometimes there is vertigo, usually headache, especially in the frontal region. The sleep is restless and disturbed by dreams. Sometimes there are pains in the bowels, and diarrhœa. But the cases in which abdominal symptoms are prominent during this stage are not common, unless emetic or cathartic medicines have been used. The transition into the regular disease takes place gradually, a regular fever sets in, often beginning with repeated chills.

The stadium prodromorum, on account of its obscure symptoms, is even yet often included in the period of incubation. In most cases it has a duration of five to ten days; but sometimes extends over two or more weeks. Sometimes it has no defined limits, beginning gradually and passing imperceptibly into the

disease. Where there are definite data, we reckon the end of the stage of prodromata and the beginning of the disease from the day on which the febrile movement begins. Where such data are wanting we must be satisfied to regard as the beginning of the disease the day on which the patient becomes unfit for work, or is obliged to take to bed. In this way, according to the character of the patient, the beginning of the disease may be dated several days too late.

In rarer cases the disease begins suddenly, without any prodromata. In such cases it may happen that the first symptom of the disease is a chill, followed by rapid increase of temperature (104° F. and more). Many of these cases, with rapid development of symptoms, run a short, abortive course; but I have seen a severe and long illness follow such a beginning.

In the *first week* of the disease proper, whilst the fever steadily increases, although observing the normal daily variations, the patient's face and surface become red towards evening. The skin feels hot, the patient himself feels hot, and sometimes in the afternoon has slight chills. The skin is usually dry, sometimes, especially in the morning, is moist, and even covered with sweat; but this latter circumstance has no favorable significance. At the same time the symptoms which were present in the precursory stage gradually increase. The headache becomes violent, especially in the frontal and temporal regions, sometimes over the entire head. In some cases the pain is most intense in the back of the head. There is a feeling of general lameness, sometimes rheumatoid pains in the back and joints. The patient feels tired, is usually obliged to remain in bed; if he stands up he feels dizzy and uncertain. The expression of his face is altered. He is silent, unwilling to think, sleepy, not easily aroused. His sleep is unquiet, with unpleasant dreams; when half asleep he becomes delirious. Sometimes there is moderate epistaxis, after which the head may seem to be freer. There is hardly any appetite, but a good deal of thirst. The tongue is at first moist, its mucous membrane somewhat swollen and sometimes thickly coated; later it becomes drier, smaller, the coating disappears or remains only in streaks, the uncovered portions are smooth and red; when pro-

truded it is often tremulous. The mucous membrane of the fauces and pharynx is often swollen and red. In many cases the bowels are at first confined, and diarrhœa only begins in the course of the first week. The stools are brown, feculent, thick or watery, without pain, and usually without tenesmus; later in the disease the discharges have the peculiar pea-soup character. In many cases, and those not the least severe, there is no diarrhœa in the first week. Towards the end of the first week the abdomen is somewhat swollen, tense, tender on pressure, especially in the ileo-cœcal region, in which situation gurgling can be produced by palpation. The urine is diminished in quantity, unless the patient drinks a great deal, and dark-colored, the urea is increased in amount, the chlorides are diminished, occasionally there is a trace of albumen. The spleen gradually becomes larger, and towards the end of the first week its increased size can be determined by percussion. Sometimes, when the patient lies on the right side, the spleen can be felt; but often this is rendered impossible by the distention of the intestines and the softness of the enlarged spleen. In many cases, at the end of the first week, an eruption of roseola appears in the lower thoracic and upper abdominal region. Often, also, there is evidence of bronchitis, especially in the posterior portions of the lungs.

In the *second week*, while the fever remains continuous at about the same degree, or in severe cases slightly rises, the skin is hot and dry, the face is flushed, sometimes livid. Gradually the results of the continued high temperature manifest themselves, and towards the end of the week the typhoid condition is more and more developed. The headache disappears, the patient becomes apathetic, drowsy, but does not sleep soundly. When asked how he is, he usually answers, very well, he has no pains to complain of. Sometimes there is ringing in the ears and moderate deafness. The more marked cases of deafness usually depend upon catarrh of the pharynx extending into the Eustachian tubes; the slighter cases depend on changes in the central nervous system. The patient does not ask to drink, but drinks readily when fluids are offered to him. All muscular movements are feeble and uncertain; the tongue is protruded

with difficulty only after repeated demands; when protruded the patient forgets to withdraw it; in speaking, the tongue is moved with difficulty, and it is hard to understand the patient. The tongue is dry, red, cracked, covered with sordes, which are often colored by small hemorrhages. The patient usually lies on his back, hardly moving, except to pick at the bed-clothes and make other feeble movements with the hands; the eyes are half closed; he mutters unintelligibly, especially in the evening; sometimes there are partial muscular contractions, subsultus tendinum, less frequently convulsions confined to some group of muscles. The urine and fæces are passed unconsciously. Other patients exhibit a more irritable mental condition. They are restless, disturbed by illusions and hallucinations, try to get out of bed, speak in a loud voice, gesticulate violently. In some patients there are rapid and repeated changes in the form of delirium. Thus in two cases in the hospital at Basle patients suddenly and unexpectedly sprang out of bed and jumped out of the window. In most patients the tympanitic swelling of the abdomen gradually increases, and towards the end of the second week, from paralysis of the intestinal muscles, there is a considerable degree of meteorismus. The tenderness and gurgling in the ileo-cœcal region are more marked. In most cases there is profuse diarrhœa; only in less severe cases is this wanting in the second week, or even in the entire course of the disease. Usually there are four to six passages in twenty-four hours, often more. The stools are thick or watery, light brown or yellow, often like pea-soup; after standing they separate in two layers; the upper is a turbid, brownish fluid, the lower is a yellow, flocculent mass; the reaction of the fluid is alkaline, it contains little albumen. In the sediment we find fragments of food, detritus, mucous corpuscles, fungous spores, accidental substances, often crystals of triple phosphate. The urine in the second week often contains a little albumen. The spleen continues to increase in size, but can with difficulty be made out by percussion on account of the tympanites. The eruption of roseola usually appears, in the first half of the second week, in the form of isolated, small, light-red spots, which when fresh disappear on pressure and are scattered over the lower thoracic

and upper abdominal regions, sometimes over a larger area. The roseola spots are often raised, so that they may be called papular. The number and extent of these spots vary; often there are not more than five to ten; often many more. In the slight, undeveloped cases they are frequently entirely wanting. Whether there are well developed cases, without any roseola throughout the entire course of the disease, I am not able to decide; in all cases which I examined sufficiently often, I have found at least a few spots. Although usually there are only a few spots over a limited area, cases occur, sometimes in large numbers, in which the spots are numerous and are scattered over a large part of the body, or even over its entire surface, and are of a deeper color. I have seen such an exanthema over the entire body, looking almost like a syphilitic roseola, in a few cases, towards the end of the third week, while the convalescence followed regularly. On examination of the thorax we find evidences of catarrh of the smaller bronchi, sibilant and coarse râles. There is often cough, but trifling compared with the amount of disease in the lungs; the expectoration is scanty, mucous, or muco-purulent; sputa from the posterior nares may be streaked with blood.

In the *third week* the fever begins to change from the continuous to the subcontinuous or remittent form, by increasing morning remissions. But it is not until the end of the week that these morning remissions have a marked effect on the condition of the patient. The severe symptoms, therefore, of the second week continue in undiminished intensity, or even increase. In many patients the symptoms which we have described as belonging to the second week, are not fully developed until the third. The patients become so weak that they can no longer raise themselves: they lie in a relaxed condition in the lowest part of the bed. The stupor may reach such a degree that the patient is no longer aroused by loud cries, or by pulling, pinching, etc. It may even happen that an acute general peritonitis, a phlegmon, or any other painful affection may be overlooked because no pain is complained of; but pressure on such painful places will excite evidences of pain. The fæces and urine are passed involuntarily; the urine may be retained, and the bladder

enormously distended. No more new spots of roseola appear, the old ones fade and disappear. At this time very often numerous small, transparent vesicles appear all over the body; they are called miliaria crystallina, or sudamina. They are also found on patients who have not perspired very freely; they have no significance. It is at this period, finally, that most of the complications are developed, of which we will speak later, especially the affections of the lungs and the bed-sores.

In the *fourth week*, while only remittent or intermittent fever remains, the results of the increased temperature and the other symptoms gradually grow less, and evidences of returning interest in life appear. The fæces and urine are no longer passed involuntarily, or, if this occurs, the patient is annoyed by it. The patient sleeps better; when he awakes he is at first somewhat confused, but soon is less apathetic and more sensible. As the mental faculties become clearer, the patient feels the exhaustion and weakness produced by the disease. Patients who during the entire course of the disease never complained, and who, while they could answer, always said they were contented, now begin to complain of weakness, and of the pains due to local inflammations, decubitus, complications, and sequelæ. The face, during the intermissions, is pale, no longer livid, is thin and sunken, but has a more natural expression. The tongue becomes gradually moister and more movable. The meteorismus diminishes, the stools are less frequent, darker and firmer. The appetite slowly returns. The spleen recedes to its natural size. The pulse gradually becomes less frequent and fuller, at first in the morning; the entire body is of a more uniform temperature. Often there are profuse sweatings, especially at the times when the temperature sinks. The patient during the course of the disease loses weight, as much as twenty pounds or more.

Thus the patient passes slowly into full *convalescence*. This is often disturbed by complications and sequelæ. It is an exceptional circumstance not to find such complications in the severe cases, such as we have been describing. And even in uncomplicated cases, months elapse before the mental and bodily functions have completely returned to their natural condition.

During the period of convalescence the appetite returns, is

keen, and may even be a ravenous hunger. But still disturbances are easily excited. The fever especially may readily be revived by causes apparently trifling, such as getting out of bed too soon, too early indulgence in solid food, all kinds of mental and bodily exertion. I have repeatedly seen the first meal of meat followed by an increase of temperature in the evening, an increase which did not usually recur on the following days, although the meat diet was continued. True recurrences may be produced by such disturbances, or may occur without known cause. Gross faults in diet may produce perforation of the intestines, or other severe sequelæ, even when the convalescence seems secure. If the convalescence progresses without any disturbance, the patients often have the feeling of unusual mental and bodily well-being, but are still easily tired by any exertion. The weight of the body rapidly increases, sometimes as much as five to seven pounds in a week.

MORBID ANATOMY.

Trousseau, De la maladie à laquelle *M. Bretonneau* a donné le nom de dothinentérie ou dothinentérite. Archives génér. de médec. 1826. T. X. p. 69, 169.—Clinique médic. T. I. 2 édit., p. 212 sq.—*Louis*, l. c.—*C. Rokitansky*, Handbuch der pathologischen Anatomie. Bd. III. 2. Abdruck. Wien, 1842. S. 237. 3. Aufl. Bd. III. 1861. S. 215.—*C. E. E. Hoffmann*, Untersuchungen über die pathologisch-anatomischen Veränderungen der Organe beim Abdominaltyphus. Leipzig, 1869.

The lesions which we find in the body after death from typhoid fever are so characteristic that they of themselves make known the nature of the disease, even if we are ignorant of the symptoms and etiology of any particular case. This is not only true of the more severe cases, but even in very mild cases where death results from some complication, an experienced observer can find enough lesions to make the anatomical diagnosis.

But however characteristic the lesions of the intestines and mesenteric glands may be, they do not alone constitute the disease. In dysentery, and perhaps in cholera, all the symptoms and all the complications seem to depend directly upon the original disease of the intestinal tract, and in these diseases we are

not obliged to assume that the specific poison passes into the blood; they are local infectious diseases. In typhoid fever, on the contrary, although the intestines are the portion of the body first attacked by the disease, we are compelled to assume that the typhoid poison is taken up by the juices of the body, and so creates a general disease, and this happens at an early period of the disease, before the characteristic symptoms are developed. The most prominent symptoms of typhoid fever are not due to the intestinal and mesenteric lesions, but to the general disease.

There is no necessary proportion between the intensity or extent of the intestinal lesions and the intensity of the general symptoms. We can indeed lay down the general rule that cases with a severe and long-continued course suffer from extensive intestinal lesions, and that in the less severe cases the lesions are less intense. But there are frequent exceptions to this rule. It happens sometimes that in very severe cases the intestinal lesions are less intense and less extensive than in milder cases. And sometimes in very severe cases the symptoms indicative of intestinal lesions may be relatively trifling.

The lesions, therefore, in typhoid fever only partially explain the symptoms. On the contrary, many of the lesions can only be understood by a consideration of the general working of the infection. For these reasons it seemed proper to describe the lesions, after giving an account of the symptoms, and to speak later of the complications and sequelæ, to understand which we must be acquainted both with the lesions and symptoms.

The admirable observations of Hoffmann, made in Basle, on the lesions of typhoid fever, are based on the autopsies of 250 persons, most of whom had been under my care at the hospital. I was almost invariably present at the autopsies. The following account is drawn principally from this material.

Hoffmann separates the manifold lesions found in typhoid fever into two principal groups. The first group includes all those lesions which belong properly to the disease itself and to its necessary consequences, and which are found in greater or less degree in every well-developed case of typhoid fever. The second group embraces those lesions which are more frequently than not observed as consequences of typhoid, but are not neces-

sarily connected with it, and have rather the character of accessory or accidental lesions. We will, for the present, only consider the first of these groups, those lesions which are found regularly in typhoid fever. Those which belong to the second group will be considered with the complications and sequelæ.

Hoffmann subdivides the lesions regularly belonging to typhoid into two groups. The *first* embraces those which represent more or less *direct effects of the typhoid poison.* To these belong the changes in the *lymphatic system of the intestinal canal*—Peyer's patches and the solitary glands. These changes consist essentially in a process of new growth combined with intense inflammation, producing increase in size of the glands spoken of, with subsequent partial destruction of them. In the same group are comprised the changes in the *mesenteric glands*, in the *spleen*, and in some other lymphatic apparatuses, which correspond in character with those of the lymphatic apparatus of the intestines. These are the lesions which must be considered characteristic of typhoid fever. They are present in all cases, without exception, as well in the fully developed as in the undeveloped cases; the only difference is in their intensity and extent. We shall call them the *primary local lesions.*

To the *second group* belong the lesions which are not the direct results of the action of the typhoid poison, but are *results of the general disease.* Such are the manifold degenerations which are found in different organs, and which are called *parenchymatous degenerations*, because they involve the essential elements of these organs. They are found in the *liver*, the *kidneys*, the *muscular tissue of the heart*, and the *voluntary muscles;* but probably occur in an analogous way in many other organs, and especially in the brain. I will also include here the changes in the salivary glands and the pancreas, changes concerning which Hoffmann leaves it undecided whether they belong to the first or the second group. Since these parenchymatous degenerations are dependent, not on the direct action of the typhoid poison, but on that of the general disease, their intensity and extent are dependent on the intensity and duration of the general disease, and especially of the fever.

In the fully developed cases, with severe and long-continued fever, they are of constant occurrence. In the milder cases they are present in less degree ; and in the mildest cases, which run their course with little or no fever, they are entirely absent.

In describing the primary local lesions, and the results of the general disease, we will again suppose a severe, well-developed case, which runs its course without special complications. The undeveloped cases will be considered in connection with this ; the complications and sequelæ not until later.

Of the *primary local lesions*, we will first speak of the *intestinal lesion*. We may distinguish several periods in the development and retrogression of this lesion which run a course somewhat parallel to that of the symptoms. As with the symptoms, we divide the course of the lesions into four weeks, and thus obtain the following scheme, which differs little from the chronology given by Bretonneau and Trousseau years ago.

In the *first week* the mucous membrane of the intestine, principally that surrounding Peyer's patches in the lower part of the ileum, becomes hyperæmic and swollen. Gradually the *medullary infiltration* is developed in a certain number of Peyer's patches and solitary follicles ; not in all at once, but on the first day a few patches and follicles are swollen, and on the successive days more and more. As a rule, the infiltration begins in the neighborhood of the ileo-cœcal valves, and extends to a distance from this on the following days. By the end of the first week all the patches are infiltrated which are likely to undergo that change.

In the *second week* the hyperæmia of the mucous membrane decreases. The infiltration of Peyer's patches continues to increase gradually, some of the swollen patches become partially or entirely necrotic. The *necrotic process*, with the formation of *sloughs* stained yellow by the bile, is nearly completed by the end of the second week. In the milder cases the necrotic process is trifling in extent, or even entirely absent ; but at the end of the second week, or in abortive cases earlier, a retrograde process sets in. In the severer cases also, at the end of the second week, a retrograde process takes place in the swollen patches which have not become necrotic.

In the *third week* the sloughs fall off, leaving losses of substance of variable extent, usually extending down to the muscular coat, often deeper. By the end of the third week the *cleaning off of the ulcers* is principally accomplished.

In the *fourth week* the ulcers cicatrize, but this process may not be completed until some time later.

In the severe uncomplicated cases we assume that the development of the process will occupy the periods named; but in order to apply this scheme to all cases, we must, as with the symptoms, reckon sometimes more and sometimes less than seven days to a week. But it happens not unfrequently that, besides the infiltrations which run their course in the regular periods, fresh infiltrations may be formed in portions of the intestine at a greater distance from the ileo-cœcal valve, and these later infiltrations then run through the same course as did the earlier ones. Thus we may find in the fourth week, in the same intestines, ulcers cleaned and cicatrizing, sloughs still adherent, and fresh infiltrations.

For the milder cases we can hardly lay down a general chronology, for the mild cases with a nearly normal course must be separated from the abortive cases. In general, the milder a case is, so much the sooner does complete restitution take place.

The *medullary infiltration* of the Peyer's patches and solitary follicles is produced essentially by an excessive development and multiplication of their cellular elements, which grow with unusual rapidity, and, after multiplication of their nuclei, divide. By this increase and multiplication of their cells the follicles are swollen in all directions. Usually the new growth extends beyond the limits of the follicles, so that the adjoining mucous membrane is also infiltrated with cells. The follicles also become thicker, the newly formed cells may wander through the muscular coat and penetrate the subserous or serous coat.

The swellings produced by this cellular new growth can be seen and felt from the outside, even before the wall of the intestine is opened. They form flat projections on the surface of the mucous membrane, projecting about 3 mm. above the surrounding surface. But a Peyer's patch may become swollen to a

thickness of 6 or even 10 mm. The extent of the individual swellings varies; sometimes only part of a Peyer's patch is involved, more frequently the new growth extends beyond the limits of the patch. In the neighborhood of the ileo-cœcal valve a number of swollen patches often become fused together so as to form masses of considerable size, sometimes forming an irregular ring. As the long axis of Peyer's patches corresponds to the long axis of the intestine, by the confluence of several patches very long swellings may be produced; Hoffmann has seen such 20–30 centims. long. The infiltration in the small intestine is usually most extensive near the ileo-cœcal valve.

The swollen patches are usually uneven, for the follicles are more prominent than the interstitial tissue. The patches, which are moderately swollen, are of a reddish or reddish-gray color, of soft consistence, have a spongy appearance, and are gradually raised from the mucous membrane. The patches, which are more swollen, are more abruptly elevated above the surrounding tissue, and may even overhang in a mushroom shape. Their color is less red, more gray, or there may be a light-brown pigmentation on the surface; their consistence is harder and firmer.

The number of Peyer's patches which are infiltrated is sometimes small, not more than three or four; in other cases nearly all the patches may be involved.

The solitary follicles are involved in the swelling in a variable degree. Usually only a relatively small number is involved, and these are not much swollen; but there are cases in which the swelling of the solitary follicles is relatively the most prominent. In the large intestine especially, the tissue around the follicles may be so infiltrated as to form large patches.

We can obtain an idea of the *extent of the morbid process* and of the number of the swollen patches and follicles, if we measure how far the lesions extend above the ileo-cœcal valve. Hoffmann has made measurements in 168 cases with the following results. The disease extended

up to	0.5	meter	above the valve	in 13	cases.
"	1.0	"	"	28	"
"	1.5	"	"	39	"
"	2.0	"	"	26	"
"	3.0	"	"	41	"

up to	4.0	meter	above the valve	in 16	cases.
"	5.0	"	"	4	"
"	6.0	"	"	1	"

In those cases in which the lesions extended far up the intestine, the jejunum, sometimes in its upper portions, was involved.

Hoffmann has also collected statistics of the frequency of lesions in the large intestine. In 233 cases there were found

No lesions in the large intestine.....			in 139	cases.
Extension of lesions into the cœcum.....			" 47	"
"	"	" colon ascendens..	" 34	"
"	"	" colon transversum	" 7	"
"	"	" colon descendens	" 4	"
"	"	" rectum	" 2	"

There were lesions in the vermiform appendix in all the cases in which there were lesions in the cœcum.

In the severer cases a smaller or larger number of the swollen patches become *necrotic.* The sloughs are stained dirty brown or yellowish green by the contents of the intestines, especially by the bile. The sloughs gradually loosen, fall off, and leave a loss of substance extending only to the deeper layers of the mucous membrane, or, more frequently, into the muscular coat, or to the serous coat. The size and form of the ulceration corresponds to that of the necrotic tissue; a Peyer's patch, which is entirely necrotic, forms an elliptical ulcer, with its long axis corresponding to that of the intestine. In the jejunum and large intestine the ulcers are usually small and round, but may be enlarged by infiltration and ulceration of the surrounding mucous membrane; these ulcers have their long axis at right angles to that of the intestines. At the end of the ileum, near the valve, there are often large, confluent ulcerations, leaving only small islets of mucous membrane between them. The edges of the ulcers are mostly sharply cut, swollen, often overhanging the ulcer. Sometimes the floor and walls of the ulcers are hemorrhagic.

Gradually the swelling of the edges of the ulcers diminishes; granulation tissue springs up from their floors, and finally a thin connective tissue membrane is formed and covered with epithelium from the edges of the ulcer. In ulcers which had extended to the muscular coat, Hoffmann never found a new growth of

mucous membrane or of villi; while the villi near the ulcers remain permanently thicker. Often the edges and floors of ulcers which have healed are more or less strongly pigmented.

The *scars* of typhoid ulcers can be recognized as such often after the lapse of years; but they seldom produce stenosis of the intestines.

In many cases the cicatrization of the ulcers is not effected in this simple way. While one part of an ulcer is cicatrizing, another part may be continuing in the necrotic process, so that neighboring ulcers may become confluent at a late period. Such *long-continued ulcers* may prolong convalescence, and even cause death. Perforation, also, may thus take place at a late period, by the necrotic process going on in some ulcer, perhaps a small one, until it reaches and breaks through the serous coat.

Those patches of infiltration which do not undergo necrosis pass through *retrograde changes*. In the milder cases this may be the case with all the infiltrated patches. Where the infiltration only exists in a moderate degree, the swelling may gradually diminish by degeneration and absorption until the patches and follicles return to their normal condition. If the follicles of a Peyer's patch retrograde faster than the interstitial tissue, this tissue may for a time form a projecting network ("plaques à surface reticulée"). Frequently, also, the swollen follicles soften and break down, and the softened matter is discharged, and in this way also the patches may acquire a reticulated appearance. Especially after this last form of retrogression, sometimes often with simple swelling, numerous little ecchymoses occur, and produce a punctate pigmentation of the patches ("état pointillé"). We can often recognize by the presence of this pigmentation the fact that typhoid fever has occurred years before.

In the retrogression which is effected by softening and discharge of the follicles the healing takes place with a loss of substance. From this to the formation of small, superficial sloughs, and of ulcers, is only a small step, and from this latter condition to that of the most extensive sloughing all transitions are found. But in those cases, also, in which there is extensive sloughing, we find in numerous solitary follicles, and also in many patches,

or parts of patches, retrogression without sloughing. In general the infiltrations in the lower part of the small intestine are more prone to slough, while those in the upper portion simply degenerate and are absorbed.

At the same time with the formation of these lesions in the intestines an analogous change takes place in the *mesenteric glands*, and they become swollen. In them also there is a cellular hyperplasia, with hypertrophy of the interstitial connective tissue. Generally the swelling of the glands is greater in proportion to the amount of the intestinal lesion, and is found most developed in the parts of the mesentery corresponding to the diseased portions of intestine. In severe cases all the mesenteric glands may be swollen. Most of the glands reach the size of a bean or a hazel-nut; some are as large as a pigeon's or a hen's egg. At first the swollen glands are hyperæmic, bluish red, tense; on section the cut surface swells up, is moist and congested. Afterwards the hyperæmia diminishes, the glands become paler, medullary, pale red, or gray. In the stage of retrogression many glands simply shrink and return to their normal condition; in others partial softening takes place. If the spots of softening are small, they may be afterwards entirely absorbed; if they are larger, absorption is incomplete, and dry, yellow, cheesy masses are left, in which after a time salts of lime may be deposited.

In some cases other lymphatic glands become swollen, the retro-peritoneal glands, the bronchial glands, etc. The lymphatic follicles, also, which surround the glands at the root of the tongue and in the tonsils are often affected in the same way; in most cases after a time the swelling disappears, but sometimes softening and rupture take place. We may, perhaps, place in the same category the small, round, gray nodules, composed of lymphatic cells, and the diffuse cellular infiltrations, which are often present in the liver, sometimes in other organs. E. Wagner[1] has drawn particular attention to these new growths. Hoffmann is inclined to believe that these accumulations of cells in the liver are composed of wandering cells from the branches of the portal vein.

[1] Archiv des Heilkunde 1860. S. 322 ff. 1861. S. 103 ff.

To the primary local lesions belong also the *changes in the spleen*, which are analogous to the changes in the intestinal follicles and the mesenteric glands, and consist essentially in an hyperplasia of the cellular elements. The enlargement of the spleen begins early, and can usually be demonstrated after the middle of the first week; it increases in the second week, and again diminishes in the fourth week. At the height of the disease the spleen reaches to double or treble its normal size, and in some cases is even larger. While the swelling is increasing the organ is tense and firm, hyperæmic, its section brownish red, the pulp projecting and covering the stroma, but not very soft. At the height of the disease the tissue is soft, easily broken, and can be scraped away with the knife in the form of a reddish-brown gruel. When the retrograde process begins, the capsule becomes relaxed and wrinkled, the hyperæmia decreases, the section is paler, of clear cherry-red color, or browner, from the presence of pigment; the tissue is again firmer, the stroma becomes prominent; sometimes at this period there are numerous small hemorrhages.

Although the enlargement of the spleen is regarded, and that truly, as one of the most constant and characteristic symptoms of typhoid fever, yet in a few cases it is absent, and that more frequently in old than in young persons. Sometimes this non-enlargement of the spleen may be explained by thickening of the capsule or of the stroma of that organ; sometimes it seems probable that the spleen was smaller than the normal before the commencement of the disease. And finally, as Hoffmann has noticed, the essential changes can be, and usually are, present, although the spleen is not strikingly enlarged.

We pass now to the consideration of the *anatomical results of the general disease*, results which occupy a prominent position among the lesions of typhoid fever. They are principally the *parenchymatous degeneration* of different organs. In some organs these changes in their development and retrogression have been closely studied; in others, in which the same changes probably exist, sufficient investigations have not yet been made.

These parenchymatous degenerations do not occur in typhoid fever alone, nor are they in any way characteristic of it. They are found constantly in all febrile diseases in which the increase of temperature reaches a sufficient degree and duration. They are absent or trivial in all cases of typhoid fever in which the increase of temperature is small. That they are found so frequently and in such a marked development in typhoid fever, depends on the fact that in this disease the increase of temperature is of longer duration than in almost any other. But these changes are not specifically different from the degenerations which occur in consequence of many poisonings, as with phosphorus, mineral acids, etc. The process is apparently the most common form of necrobiosis, such as is produced by all conditions which result in a slow death of cellular elements.[1]

In the *liver* the cells become more granular; in many of them are numerous fat granules; the nuclei can no longer be seen. In the higher degrees of degeneration the cells lose their sharp contour, they appear like a conglomeration of granules, and finally they lose all cohesion and break down into a formless mass of granular detritus. Even in moderate degrees of degeneration the scanty amount of blood in the small vessels, and the uniform color of the section, in which the acini can hardly be recognized, strike the naked eye. The color is grayish red; in advanced degeneration, grayish yellow or orange; the consistence of the organ is diminished. The extent of these lesions depends principally on the degree which the temperature has reached. If this was not high, the changes are slight, or entirely absent. But if death occurs after high fever, and at the acme of the disease, one can safely reckon on finding considerable and striking changes in the liver. The degeneration is often more advanced in some portions of the liver than in others, especially often is the right lobe more changed than the left.

Hoffmann found in 174 livers of typhoid patients:
In 38 cases no changes, or slight ones.
In 95 cases marked granular degeneration and partial destruction of the cells.
In 21 cases general destruction of the cells.
In 20 cases marked new growth.

[1] Compare Deutsches Archiv für klin. Medicin. Bd. I. 1866. S. 328 ff.

The retrograde process, after these changes in the liver, takes place in this way: the cells which were only granular return to their normal condition; the cells which were broken down and converted into detritus are absorbed. But even in cases in which the larger number of the cells are destroyed, if the disease runs a favorable course, the cells may afterwards be regenerated in this way, that in the remaining cells the nuclei are increased in number, and then a division of the cells follows.

Hoffmann has studied the process of new growth of cells in the livers of individuals, who, after passing through a severe attack of typhoid fever, died during the period of convalescence. It was shown by repeated countings that at this time the number of cells with two or more nuclei is much greater than the normal. Hoffmann found in normal livers, and in livers during the early stages of typhoid, 110–116 nuclei in every 100 cells, about the same proportion as that which I found in normal livers (110–120 nuclei in 100 cells). In livers, during the period of convalescence, he found 136–150 nuclei in every 100 cells. But the process of new growth seems to be more energetic than is denoted by these figures, for there are also found large numbers of small, single, nucleated cells, which Hoffmann believes to be the products of a hardly completed cell division.

The secretion of bile is often markedly diminished. Hoffmann found, in one-fourth of the cases, the bile to be thin, less intensely colored, or colorless.

Parenchymatous degeneration occurs in the *kidneys* in the same way as in the liver. The epithelium, first of the cortex, later of the pyramids, becomes granular, the nuclei disappear, the contours of the cells become indistinct, and finally the cells break down into granular detritus. The cortex becomes soft, on section appears uniformly gray, sometimes yellowish. According to Hoffmann's experience, it is something exceptional to find no changes in the kidneys, although there are many cases in which these changes are not marked. In the kidneys also the changes are more pronounced in proportion to the degree and duration of the fever.

Albuminuria frequently occurs at the height of the disease, and is generally observed in cases where there is marked degeneration. But there are exceptions, and I have repeatedly seen temporary or entire absence of albuminuria during the disease, when the autopsy showed that the kidneys were in a condition

of advanced degeneration. This is only true as to the albumen, which can be demonstrated with heat and nitric acid; whether the albuminous substances which can be precipitated with alcohol[1] were present, was not observed.

The existence of parenchymatous degeneration in the *muscular tissue of the heart*, a condition which is the rule in the severer cases, is of great importance for our proper comprehension of the symptoms. In the lesser degrees of this change we find here and there in the muscular fibres, especially above and below the nuclei, dark granules, often highly refractive. In more advanced changes granules are present in larger numbers, partly arranged in long rows; finally the muscular fibres are filled with granules and the striation disappears. Besides these granules, there are often numerous brown pigment granules. It is but seldom that we find in the heart the form of waxy degeneration which is found in the other voluntary muscles. In the higher degrees of the degeneration the heart is flaccid, soft, easily torn, pale gray, yellowish, or reddish brown in color. In the cases which terminate favorably regeneration is effected in a way analogous to that which occurs in the voluntary muscles.

Of the cases of typhoid fever, in which the heart muscles were examined, Hoffmann found that—

In 56	cases	the muscles were	normal or little changed;
" 39	"	"	slightly granular, the striations still visible;
" 46	"	"	very granular;
" 19	"	"	slightly waxy without much granular degeneration;
" 1	"	"	very waxy.

The disturbance of the heart's functions, especially the weakening of its action, which in numerous cases goes on to complete paralysis, has been already mentioned in the symptomatology. Generally the degree of degeneration corresponds to the degree of functional disturbance observed during life.

The *vessels*, also, usually share in the parenchymatous degeneration. In the smaller vessels this takes the form of fatty degeneration; in the larger vessels, of thickening and opacity of the inner coat. Hoffmann calls attention to the relative fre-

[1] Compare *Gerhardt*, Deutsches Archiv für klin. Medicin. Bd. V. 1869. S. 212 ff.

quency of extensive opacities and thickenings of the inner coat of the pulmonary arteries, in which otherwise such changes are rare.

At the height of the disease the *blood* is very dark-colored; after coagulation it presents a small and soft clot. In the dead body the veins are usually distended with dark, fluid blood Sometimes, especially if the temperature has been very high, the blood is not only dark-colored, but is thick, syrupy, and sticky, while all the viscera are very dry. Later, and especially during convalescence, we often find the vessels nearly empty; the blood thin, watery, with small gelatinous, fibrinous clots; the tissues œdematous.

Parenchymatous degeneration of the *voluntary muscles* was first described by Zenker[1] as an almost constant occurrence in typhoid fever. He distinguishes two forms of degeneration. The first of these, *granular degeneration*, corresponds in its higher degrees to ordinary fatty degeneration; while in the lesser degrees the striations are obscured by an opacity produced by granules, which are partly soluble in acetic acid. The second form, *waxy degeneration*, consists in a conversion of the contractile substance of the primitive bundles into an homogeneous, colorless, waxy, shining mass, in which the striations entirely disappear. The appearance of such muscles reminds one of that of tissues which have undergone amyloid degeneration; but they do not give the proper reaction with iodine and sulphuric acid. In both forms of degeneration the muscular fibres become thicker and more brittle. In waxy degeneration the fibres are often broken. After a time the degenerated muscles break down into a mass of fine detritus, which is finally absorbed. In waxy degeneration a return to the normal condition seems impossible, while granular degeneration, if not too far advanced, does not seem to exclude such a return. Often we find both forms of degeneration together, sometimes one, sometimes the other predominating. In the highest degrees of degeneration we find in smaller or larger areas only a few muscular fibres, or none at all.

[1] Ueber die Veränderungen der willkürlichen Muskeln im Typhus abdominalis. Leipzig, 1864.

During the first week of typhoid fever the muscles appear very dry, mostly dark red or reddish brown, almost of the appearance of smoked meat. The places where degeneration is most advanced are paler; they are yellow with fatty degeneration, gray with waxy. In the highest degrees of degeneration entire muscles may appear yellowish gray or whitish gray, so that hardly any traces of red color are left; at the same time the section has a dull reflex, smooth and dry; the muscles are very brittle. At first there is some swelling, later a decrease in size. In convalescence the muscles become much moister, and their natural red color returns. Hoffmann found the degeneration most marked usually in the second, third, and fourth weeks; later than this it disappears, or is only seen in its results. But exceptionally degeneration of the muscles is found at a late period of the disease.

Zenker demonstrated that this degeneration of the muscles is by no means peculiar to typhoid fever, but that it occurs also in other severe febrile diseases. He arrived at the conclusion, therefore, that the degeneration of the muscles is a part of the manifestation of the fever, and depends on derangement of a centre regulating the nutrition of the muscles. According to our opinion, parenchymatous degeneration of the muscles is, in many cases, and especially in typhoid fever, the result of long-continued high temperature. But we do not exclude the possibility that similar necrobiotic processes may be produced in other cases by other causes, which effect a gradual death of the tissues. In fact, I have found generally the muscular degeneration advanced in proportion to the increase of temperature.

Zenker designates the adductors of the thigh, and next the recti muscles of the abdomen, as the ones most frequently affected by marked degrees of this degeneration; but in individual cases numerous other muscles are found in the last stages of degeneration, and all the voluntary muscles seem to share in the lesser degrees.

Hoffman found, out of 127 cases in which he examined the abdominal muscles, in 96 cases well-marked waxy degeneration: in 35 cases in one group of muscles, in 61 cases in several. The 31 cases in which there was no waxy degeneration belonged mostly to the later periods of the disease. With the waxy degeneration there was in all cases granular degeneration, which was present in most of the other cases also. Of the individual groups of muscles there were:

	Examined.	Found waxy.
The adductors of the thigh	107 times.	75 times.
The rectus abdominis and pyramidalis	127 "	87 "
The pectorales, major and minor	77 "	29 "
The muscles of the tongue	82 "	13 "
The diaphragm	22 "	16 "

Waxy degeneration was also found in many other muscles. Hoffmann calls attention to the fact that the favorite situations are those groups of muscles which in each patient are the ones most used.

The regeneration of the partly destroyed muscles is, according to Hoffmann, effected from the primitive fibres which remain. The nuclei of these fibres multiply, are surrounded by protoplasm, gradually grow into a broad, fusiform shape, are set free, and join together to form new primitive bundles.

The extraordinary want of muscular action which exists at the height of the disease, depends in many cases on disturbances of the central nervous organs, which do not permit the impulse of the will to exhibit itself in muscular action. But the demonstration of a degeneration of the voluntary muscles, at the height of the disease, explains the weakness of the individual muscular contractions. At the beginning of convalescence, when the marked disturbances of the mental functions have ceased, the excessive loss of power of which the patients complain, which makes every muscular action an impossibility, depends essentially on the changes in the muscles. Only gradually, as the muscles are regenerated, does the physical strength return, and it may be months before the full force is re-established.

The proof that the *muscles of the tongue* are degenerated in the same way as the other voluntary muscles, leads to the question, how far the trembling of the tongue, the difficulty in moving it, the stammering speech, etc., are dependent upon this degeneration. Exact observation shows that at the height of the fever the imperfect speech depends usually, in great measure, on disturbances in the central nervous system. Part of the difficulty of movement, however, must be laid to the dryness of the tongue, and part to the degeneration of its muscles. As the severe nervous disturbances cease, the speech usually improves decidedly ; but the last traces of difficulty in moving the tongue

only disappear when the regeneration of the muscles is accomplished.

Hoffmann examined the muscles of the tongue in 60 cases belonging to the second, third, and fourth weeks of the disease. He found in 13 cases waxy degeneration, and in 34 cases granular degeneration (in 20 cases extensive, in 14 cases slight). In 13 cases there was very slight or no change in the muscles of the tongue. In the later periods of the disease he found that in 22 cases only 6 had marked granular degeneration, and none waxy degeneration, but newly formed elements were not uncommon.

The further results of the degeneration of the muscles, the ruptures, hemorrhages, etc., will be treated of with the complications and sequelæ.

The marked disturbances in the functions of the *central nervous system*, which constitute such a prominent part of the lesions in severe typhoid fever, are in most cases, and for the greatest part, results of the increased temperature. But it seems probable that in the brain, as in other organs, these disturbances are due to degeneration of the brain tissue resulting from the high temperature. And the fact that in severe cases these disturbances and the simple weakening of the brain functions continue during convalescence, and only slowly disappear, shows clearly that these disturbances are produced by material changes.

Unfortunately, pathological anatomy has so far furnished us with no satisfactory answer to this important question, partly, it is true, because the critical examination of the finer histological changes in the brain is very difficult, and partly because no investigator has yet occupied himself closely with this question. Before the time of Zenker changes so obvious and so easily accessible to microscopic investigation, as those of the voluntary muscles, were almost unknown. We should not then be surprised that we know so little about the minute condition of the brain, and we may still regard it as probable that a thorough and comprehensive examination of this organ, in cases of typhoid with severe functional disturbance, will determine the existence of constant and definite parenchymatous changes.

What we know, so far, about the condition of the brain, is in some measure calculated to lend support to this conjecture.

Among the grosser changes, more or less extensive adhesions of the dura mater to the inner surface of the cranium are especially common. Then, too, we sometimes find a considerable injection of the pia mater with great congestion of the brain itself, especially in the first period of the disease; but we very frequently find œdema of the pia mater, associated sometimes with opacity; while ordinarily the brain substance itself is thoroughly œdematous, and the ventricles are moderately distended with fluid. Buhl, who has made accurate quantitative estimates of the infiltrated fluid, declares this œdema of the brain to be the cause of the psychical disturbances; and, besides, in some of the Basle cases, which were characterized by unusually violent cerebral symptoms, a very marked œdema of the brain was found at the autopsy. At a later period of the disease we often find a decided atrophy of the brain, which is made manifest by the small size of the convolutions, and by the greater width of the lateral ventricles; and Hoffmann properly reminds us that such a shrinkage of the volume of the brain would necessarily lead us to infer antecedent changes of the nervous elements. Besides this, we often find diminished firmness of the brain substance, particularly when there is an increase of serum, and this may sometimes, in spots, go on to a more or less advanced degree of simple softening. Finally, the gray substance of the cortical part of the brain and of the interior is sometimes of a rather yellowish brown color, and we notice besides, diffuse yellow and blackish brown spots in different places, particularly in the corpus striatum and thalamus opticus. In such places the microscope shows a diffuse yellow coloration, a deposit of small brown pigment granules, and also, especially in the optic thalamus and corpus striatum, the ganglion cells thickly crowded with brownish or blackish pigment granules in such numbers as to conceal the outlines of many of the cells. Hoffmann found this condition of the ganglion cells in nine cases, although he examined only comparatively few brains with this object. He is inclined to place this by the side of the *parenchymatous degeneration* of other organs, and it might be designated as pigment degeneration of the ganglion cells. In certain cases we also find nerve fibres which are the seat of fatty degenera-

tion, and sometimes an abundant deposit of pigment and fat granules in the capillaries of the brain.

Hoffmann observed a firm adhesion of the dura mater to the calvarium in 32 out of 166 cases, while slighter adhesions occurred in a very great number.

He also found an increase of fluid in the brain and its meninges in varying degree in more than four-fifths of the cases examined. More marked œdema, with considerable distention of the lateral ventricles, occurred 56 times out of 166 cases. This higher degree of œdema of the brain was found with especial frequency in the fourth week of the disease.

According to the investigations of Hoffmann the *salivary glands* in typhoid fever exhibit certain well-nigh constant alterations, apart from suppurative parotitis, which will be discussed with the complications. In the first period of the disease they appear firmer and denser, assume a more or less intensely brownish-yellow aspect, and feel very tense. The separate divisions of the glands, too, are very hard, with something of the consistency of cartilage, and creak under the knife. In such cases the microscope reveals the acini of the gland filled with closely crowded, very large, generally multinuclear, highly granular cells. Later on, numerous granules, consisting partly of fat, appear in these cells; they become turbid, lose their sharp outlines and a part of them break down. The glands gradually become again redder and softer, and the hardness and tension diminish. It seems, then, that we actually have here a parenchymatous degeneration, which only differs from the analogous processes in other organs in that an increase of the cells precedes the degeneration.

Among 42 cases in the second and third weeks Hoffmann found the alterations under consideration 35 times; among 18 cases in the fourth week, 10 times; and among 10 cases in the fifth week, twice.

These changes in the salivary glands, in which the parotid, the submaxillary, and the sublingual alike participate, explain the diminution of the salivary secretion, which also has some share in causing the dryness of the patient's mouth.

The *Pancreas* also exhibits perfectly analogous changes, for its cells take on proliferation, which results in tumefaction and enlargement of the gland, with noticeable increase

of hardness, and which is subsequently followed by a degeneration of the cells.

Finally, we should perhaps consider here the alterations of the medulla of the bones, which have been particularly studied by Ponfick.[1] In the medulla of the bones, as well as in the pulp of the spleen, are found numerous cells containing blood-corpuscles, which often attain an enormous size and are capable of containing twenty-five blood-corpuscles or even more. During the period of convalescence the blood-corpuscles are transformed into pigment, and we often find an enormous quantity of large cells which are filled with granules and masses of pigment, or are colored uniformly of a yellowish brown. In consequence of this the medulla often appears rusty brown, even to the naked eye. Ponfick is inclined to regard these processes in the spleen and in the medulla as methods of disposing of the elements of the blood which have become useless. Like changes also occur in typhus, relapsing and intermittent fevers, in pneumonia, pleurisy, and other febrile diseases, and on this ground I believe that they ought to be considered as changes primarily dependent on the fever.

CONNECTION BETWEEN THE SYMPTOMS AND THE LESIONS.

Hoffmann, loc. cit., p. 391 et seq.

In the discussion of the symptoms and the anatomical changes, we have already referred to their mutual relations. If we add to and complete the suggestions there made we will obtain a more perfect idea of their relations, but an idea which is still imperfect.

The specific poison of typhoid fever is generally introduced into the intestinal canal by the ingesta, in other cases, by the air we breathe, which deposits particles in the form of dust in the cavities of the mouth and pharynx, or in the sinuses of the nose, and these particles are subsequently swallowed. In the

[1] Virchow's Archiv. Vol. LVI.—Compare *Neumann*. Centralbl. für die Med. Wissenschaften. 1869. No. 19.

lower part of the ileum, where the lymphatic follicles are present in the greatest number, and are clustered together in large glandular patches; where, too, the ingesta are delayed for a considerable time, the poison finds a suitable place to attach itself. It is taken up by the lymphatic follicles, and through these reaches the mesenteric glands. It remains almost latent in the lymphatic organs during a long period of incubation, and during this time it possibly goes through one phase of its development. But at last the poison is taken into the blood, and from this is deposited in various other lymphatic organs and in the spleen. It begins at once to exercise its effect upon the lymphatic organs, by exciting in them an abundant proliferation of cells. The general disturbances are provoked by the operation of the poison, which is constantly passing in great quantity into the blood; but, perhaps, also by the peculiar products formed by the conversion of matter in the lymphatic organs, such as newly formed lymph cells and the like. Its effect upon the centres regulating the heat of the body results in fever, which continues according to its type until the poison has gone through its further phases of development within the affected lymphatic organs, and probably also within the blood, and has itself either become inoperative or has been eliminated from the body. The partial necrosis of the new lymphatic formations may possibly depend on this, that by their very bulk, and by being closely crowded together, they compress the neighboring vessels to such a degree that a rapid destruction of them necessarily follows. More probably, however, there is a special deleterious effect of the specific poison or of its products, both in the slow necrobiosis and the rapid necrosis of the infiltrated organs. Thus the primary local affections originate as more or less direct consequences of the typhoid poison.

Comparatively few of the serious functional lesions, which make up the sum and substance of the disease, are to be referred to these primary local affections. In reality only the diarrhœa and the various abdominal symptoms belong to this category.

Besides this first, and relatively primary series of lesions, a second series is developed, which is to be considered as relatively

secondary, and mainly depends upon the effect of the fever, that is, upon the elevation of the temperature. Here belong, in the first place, those disturbances of function which are directly due to the elevation of temperature, without any appreciable material changes having necessarily preceded them; and in the next place the parenchymatous degeneration of various organs, with the functional lesions due to this degeneration, Thus, for example, the increased frequency of the heart's action is directly due to the elevation of temperature, while the feebleness and paralysis of the heart, which occur later, are less immediately due to this cause, but are still in part dependent upon the degeneration induced by it. Here, too, belong the functional lesions of the nervous centres, the disturbances of stomach and intestinal digestion—so far as the latter is not dependent on the primary local affection—the diminution of secretion, etc.

The opinion that the parenchymatous degenerations in typhoid fever are generally and chiefly due to the increase of the temperature of the body, is sustained by the fact that the degree they attain is distinctly related to the degree and duration of the elevation of temperature, as already mentioned when discussing the individual lesions. Hoffmann also, in his extended investigations, "has seen the parenchymatous degeneration of organs reach an especially high development in the severest cases, *i.e.*, in those in which a very high or long-continued elevation of temperature occurred," and he has likewise "observed it under similar circumstances in a great number of other affections (pneumonia, puerperal fever, pyæmia, septicæmia, small-pox," etc.). He therefore agrees with the opinion which I have advocated, and also regards "the elevation of temperature as a controlling element in the determination of parenchymatous degenerations."

Of late years some experimental investigations have been made into the effect of an elevation of temperature upon the organs. Thus Iwaschkewitsch [1] found that in rabbits and dogs, under the influence of an artificially elevated temperature, the heart and liver lost weight, while at the same time a more or less pronounced granular clouding of the individual elements of the tissue took place, and Wickham Legg [2] observed in the liver, and largely also in the kidneys and heart of rabbits and guinea-

[1] Anatomico-pathological Changes in the Parenchymatous Organs under the Influence of an Elevated Temperature. Dissertation. St. Petersburg, 1870. (I am indebted to the kindness of Dr. Manasseïn for the translation of the original Russian.) Comp. *Virchow* und *Hirsch*, Jahresbericht für 1870. Vol. I. p. 179.

[2] Parenchymatous Degeneration of the Liver and other Organs, caused by raising the Natural Temperature of the Body. Transactions of the Pathol. Society. Vol. XXIV.

pigs, which he had killed by a gradual elevation of the temperature, the distinct beginnings of parenchymatous degeneration. A further continuance of such experiments will, perhaps, lead to a positive settlement of the question regarding the effect of the elevation of temperature upon the organs.

Besides, there can be no mistake that precisely in typhoid fever there are various other conditions favorable to the existence of parenchymatous degeneration. Thus we should specially bear in mind the general impairment of nutrition, and also—so soon as the heart has markedly degenerated, as a result of the elevation of temperature—the general diminution of the circulation. We shall speak further on of the significance of certain special conditions.

By the beginning of the fourth week the phase of development of the poison, which takes place within the body, appears to be completed, and the poison itself is then either expelled, or becomes harmless. The disease is, in fact, at an end; but the body is shaken and undermined throughout, partly by the more direct effect of the typhoid poison, partly by the severe and long-continued fever. A large part of the cellular elements composing it are irreparably destroyed, there are even large cavities, and withal there is a mass of dead material, or material ready for decomposition, scattered through all the tissues. The period of convalescence has begun, in which a double task is imposed upon the body, emerging as it does like a wreck from the storm; on the one hand, it has to throw overboard the ruined parts and clear the deck; on the other, to restore the sails and rudder. But the task is very difficult. Not seldom the water will rush in through a leak so fast that all our efforts scarcely suffice to check it, and while all our energies are strained in this direction, the ship, without sails or rudder, is swept ashore by the next wave or dashed against the rocks. The period of convalescence is also the period of sequelæ, which carry off many a patient who has withstood the disease itself.

The fever in the fourth week, with its marked morning remissions and evening exacerbations, is no longer to be regarded as essentially the effect of the typhoid poison, nor is the fever which often drags along later in the period of convalescence or reappears as the so-called after-fever. This is a symptomatic fever, which is due to the local affections still present or freshly

developed, and, at the beginning of the period of convalescence, may be referred to the absorption and elimination of the organic detritus.

Hoffmann thus closes his work, in which the destruction caused in the body by typhoid fever is detailed with a completeness not hitherto attained: "When we see how large portions of important organs in all the divisions of the body are ruined by the typhoid process, it becomes intelligible to us why typhoid patients are generally long beset with great feebleness, and why typhoid fever requires so much longer a period for convalescence than many a less severe malady. The restitution of such a great quantity of important constituents of the body, which had been destroyed, demands the whole activity of the parts which have been preserved, and is rendered yet more difficult by the fact that the very avenues of admission for the nutritive material are essentially injured by the destruction of large areas of the lymphatic apparatus in the intestine. But so much the more are we filled with admiration for the actively creating force, which, in spite of all these obstacles, builds up anew, as it were, a great part of the body, and we realize that when the convalescent, who has happily passed through typhoid fever, feels rejuvenated and renewed, there is a substantial ground for the feeling.

CASES WHICH RUN AN IRREGULAR COURSE.

H. Lebert, Beiträge zur genaueren Kenntniss der verschiedenen Formen des Typhus. Ueber Abortivtyphus. Prager Vierteljahrschrift. Bd. LVI. 1857. S. 4 ff.—*Griesinger*, l. c. 2. Aufl. S. 162 und 234 ff.—*Chr. Bäumler*, Deutsches Archiv für klin. Medicin. Bd. III. 1867. S. 387 ff.—*Th. Jürgensen*, Ueber die leichteren Formen des Abdominaltyphus. Sammlung klinischer Vorträge. Nr. 61.

The typhoid poison in its operation upon the human body by no means always effects the serious changes and symptoms which we have hitherto described. On the contrary, as we have already hinted, there are many cases that run a milder course; we find them less and less severe, till finally we come to those so mild that they scarcely warrant the name of disease.

There is nothing remarkable in this. One would rather suppose, *à priori*, that in every disease due to a specific poison, besides the severe, perfect cases, there may also occur less perfect ones of a mild character, where the quantity of the poison received is insufficient to produce a severe attack; or else the predisposition of the individual is so slight that but an insignificant attack follows the reception of even a large portion of the morbific poison. In numerous epidemics the imperfect cases are more common than the perfect ones.

The imperfect cases show a great diversity in their course, but we may distinguish two essentially different types. It is customary to designate the imperfect cases indifferently as mild typhoid or abortive typhoid; but it may perhaps be well to make a distinction here and employ these two terms to designate two main types. There are two ways in which a case may fail of a perfect development, viz.: Either the severity of the symptoms is slight: *mild typhoid*, or the duration of the disease is markedly shortened: *abortive typhoid.*

In *mild typhoid* the symptoms are only moderately severe, and the fever especially is not of a high grade. Under this term may be included cases in which the temperature in the rectum does not exceed 104°, or only does so for a short time. Moreover, the commencement of the disease is usually gradual; there are generally prodromata which, as a rule, merge without marked boundary into the disease proper. Light rigors may occur for one or two days; a chill is uncommon. The disease often continues for the usual length of time. I have not infrequently observed cases in which the temperature did not exceed 104°, or only did so on a few evenings, and in which no severe or threatening symptoms ever appeared, but still the fever lasted for four full weeks. In these cases the temperature-curve corresponds exactly to that in severe cases, with the difference only that it runs about one degree lower. But in the great majority of cases the mild typhoid has a shortened course, so that each of the four periods comprises only about four or five days, and often the course is still further abridged, the mild typhoid becoming likewise an abortive typhoid.

Under *abortive typhoid* belong, in its more restricted sense,

those cases which begin like the perfect cases, with high fever and grave symptoms, but in which certain periods, especially the febris continua of the second and third weeks, are reduced to a very short duration or are omitted entirely. Such cases often begin suddenly, without prodromata; the temperature rises rapidly so as to reach 104° on the second or third day. The rapid rise in temperature is accompanied sometimes by rigors, or even a chill. For some time the temperature lingers at its height, and then the morning remissions begin, and the course of the temperature corresponds to that of the fourth week of the severe cases, excepting that the return to the normal temperature is much more rapid, and is often accomplished within a few days. Sometimes the absolute grade of temperature is very high. For example, I have met with cases in which the temperature in the axilla rose to 106°, or still higher, and yet the total duration of the fever amounted to from seven to twelve days only. But these abortive cases are also very frequently mild, the temperature never exceeding 104°, with the exception of a few evenings, and we have then the common form which we have already mentioned, the mild abortive typhoid.

In these imperfect cases, as the fever is moderate or has but a short duration, so all the symptoms, particularly those derangements which depend upon the elevations in the temperature, are developed only in moderate degree. Moreover, the symptoms characteristic of typhoid fever are often only present to a partial extent. For the sake of obtaining an approximate estimate of the frequency with which these symptoms occur in the mild and abortive cases, I have looked over the histories of 100 patients of this class who were in the hospital at Basle from the years 1865–6. Only those cases were chosen in which the axillary temperature had never exceeded 104°; in many of them, in fact, a temperature not over 102.5° was observed. Furthermore, only cases with markedly shortened course were selected; many were only two to three weeks under treatment; in no case had the duration of the treatment, up to the time the patients were sufficiently recovered to resume work, amounted to over one month. In these 100

histories enlargement of the spleen is noted in 71 cases, diarrhœa in 41, a distinct roseola in 21.

In many places the mild cases—in the restricted sense—seem to be of more frequent occurrence ; in others, the abortive cases are more common. For instance, in Basle the cases of mild typhoid predominate decidedly, though cases of the abortive form occur also. In Kiel, according to the observations of Jürgensen, the abortive type appears to make up the bulk of the imperfect cases.

Jürgensen includes under the milder forms all the cases in which the total duration of the fever amounted to but sixteen days or less. The cases upon which his description is based began for the most part suddenly, so that the patient was enabled to give the day with certainty. This was the case in 74 out of 87 patients, and all the cases, in which the duration of the fever was only ten days, commenced without exception in this way. Nearly half of the cases began with a chilliness, and, in fact, usually with a well-marked chill. The absolute height of the temperature was often very considerable. Both enlargement of the spleen and roseola made their appearance quite early (in from two to three days). In only 7 out of 88 cases is enlargement of the spleen noted as not discovcrable. Roseola was present in 46, that is, in 75 per cent., diarrhœa in 16 per cent., and tenderness of the ileo-cæcal region was present in almost every case. Subsidence of the fever usually took place gradually, in from twenty-four to seventy-two hours.

As a rule the imperfect cases pursue a favorable course. Nevertheless, in very aged persons, in those otherwise diseased, or in convalescents from other diseases, etc., the disease may prove fatal. Moreover, in young, strong persons, a mild typhoid running its course without any serious symptoms whatever, may, in the event of a considerable intestinal hemorrhage, perforation of the bowel, or some other grave complication (as pneumonia, endocarditis, or apoplexy), become suddenly very alarming. Amongst the fatal instances of perforation which I have observed, are several cases in which the fever ran a very mild course, and in fact there was one case which, but for the fatal complication, we should certainly not have regarded as typhoid at all, but merely as a febrile abdominal catarrh. Louis[1] has also related a case that ended fatally through perforation of the intestine, in which the symptoms were so insignificant

[1] L. c., Observation 41. Tome II. p. 332 sq.

that, had the case gone on favorably, a simple "*embarras gastrique ou intestinal*" would have been diagnosticated.

The convalescence in the mild or abortive cases proceeds with comparative rapidity, and frequently, in one or two weeks from the complete cessation of the fever, the patients are able again to return to their occupations. The convalescence may, however, be prolonged or interrupted by subsequent attacks. Relapses are particularly liable to occur; they sometimes pursue a mild and brief course, but sometimes are severe.

The *anatomical changes* can only be examined in the few cases that terminate fatally, in consequence of a special complication or of some accident. The result of the autopsy in such cases confirms what would be inferred from the symptoms during life. In the mild typhoid, the medullary infiltration is slight, both in intensity and extent. Still, there are cases in which the infiltration extends over a large portion of the bowel. Sloughing, as a rule, occurs only in small spots, and the ulcers remain small and superficial. Probably in very many cases necrosis and ulceration do not take place at all; but it has been mentioned already that small, deep, and even perforating ulcers may exceptionally occur. Enlargement of the mesenteric glands and spleen is but moderately developed.

In the abortive typhoid the necessary supposition is that at first considerable swelling of the *plaques* takes place, but that the recession begins very early, and that sloughing and ulceration either do not occur at all, or to a minimum extent.

It has been already observed that between the most severe form of typhoid and the mildest and abortive cases we may have every conceivable grade of the disease. But what is the lowest limit? Are there not also cases in which the quantity of active poison is so minute, and perhaps also the predisposition of the individual so slight, that it does not ever amount to a positive disease, but only causes, it may be, some such symptoms as belong to the prodromic stage? According to my experience I must give to this question an affirmative answer.

When I first came to Basle certain of my colleagues, Prof. Miescher, Sen., particularly, related to me instances of affections which ran their course without fever, and yet could, with good

reason, be referred to typhoid infection. I regarded these statements with a certain degree of incredulity, not being disposed to give up the view, also held by Griesinger (l. c., p. 178), that there is no such thing as typhoid without fever. It was not long, however, before I had some personal knowledge of cases answering to the above statements, and ascertained that in Basle they were of frequent occurrence. Thus, in my division of the hospital, in the year 1869, besides 206 cases of more or less perfectly developed typhoid fever, there were also under treatment twenty-nine cases of febrile, and 139 cases of "afebrile abdominal catarrh," no inconsiderable portion of which, I believe, are to be imputed to typhoid infection. In the year 1870, besides 161 cases of typhoid, there occurred twenty-six cases of febrile, and 111 cases of afebrile abdominal catarrh. Similar proportions obtained for the remaining years.

The cases of febrile abdominal catarrh belong, without doubt, in part to typhoid fever, following immediately in the train of the lightest forms of the latter disease; then, after the febrile abdominal catarrhs, come, without a definite boundary, the afebrile cases. Under these last would also be included those in which a slight elevation of temperature, say 100.5° in the axilla, occurs occasionally. In some cases, too, it may be that such elevations of temperature occurred before the commencement of the observations in the hospital. Most of the cases during the time that they were under observation never showed any elevation of temperature at all. In some of them the temperature had been noted from the commencement of the illness outside the hospital, and the absence of fever during the whole time was ascertained with certainty, and the same was observed in a number of patients in whom the disease made its first appearance while they were inmates of the hospital.

Among the afebrile cases many showed an evident enlargement of the spleen and in some few cases an unmistakable roseola was observed. The action of the bowels was generally irregular; sometimes diarrhœa, sometimes, again, obstinate constipation existed. All the cases which appeared to belong to this class manifested in common decided impairment of the general health, great lassitude, depression, languid expression

of countenance, pains throughout the body, often headache and especially persistent loss of appetite, with more or less swollen and furred tongue. The long duration of an apparently trifling indisposition is particularly noticeable; many of these patients are confined to their beds for as much as four weeks or longer. Finally, there is something striking in the markedly diminished frequency of the pulse, while its quality is not appreciably altered; very often the frequency of the pulse does not exceed sixty to the minute, and is sometimes only forty-eight or even less. With convalescence the pulse again increases, though the patients do not yet leave the bed.

It is to be observed also that in Basle more than in other places it is common to find in persons who have died of other diseases, or in consequence of accidents, a moderate swelling of Peyer's patches, and it is noticeable also that the phthisical ulcers of the intestines in adults attack by preference the Peyer's patches more commonly here than they do elsewhere. Moreover, these facts by implication show that the widespread distribution of the typhoid poison in Basle gives rise frequently to a minimum infection, which however does not manifest itself outwardly by any marked symptoms.

Meantime it is not possible to draw a sharp line of distinction between the cases of febrile and afebrile abdominal catarrh belonging to typhoid fever and those which simply depend upon catarrh of the stomach and bowels. In addition to the symptoms, a circumstance of importance in deciding the question will be their occurrence mainly at the same time and in the same houses with perfect cases of typhoid fever; but in many individual cases the etiology will very likely remain doubtful. Still, it is certain that many cases of abdominal catarrh, as well as many "gastric disturbances, gastric fevers, mucous fevers," are etio-

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[1] Concerning these afebrile forms compare *Liebermeister* and *Hagenbach*, Aus der medicinischen Klinik zu Basel. Leipzig, 1868, p. 19 ff.— *Vallin* relates a case of severe intestinal hemorrhage in a typhoid patient, who had been previously free from fever, and again, of a fatal case of typhoid fever, death being caused by peritonitis, in which likewise no fever had been present until the peritonitis occurred. De la forme ambulative ou apyrétique grave de la fièvre typhoïde. Archives générales de méd. Nov 1873.

logically identical with typhoid fever, and merely represent its lighter forms.

In reference to the so-called *gastric fever* and *mucous fever*, many physicians of the present day go so far as not only to regard many of these cases as light forms of typhoid fever,—which is undoubtedly correct—but as to deny absolutely the existence of any such fevers not depending upon typhoid infection. On the other hand, Niemeyer,[1] within a few years, has defended the view that there is such a thing as a febris gastrica and mucosa which is not due to infection with typhoid poison. And Wunderlich[2] regards it as not impossible "that under the name of typhoid fever two essentially different, although in many symptoms, and even in their anatomical relations, very similar diseases are included together: first, a general disease due to infection, but localized in the glandular apparatus of the intestine; and second, a local enteritis in which from individual causes the follicular apparatus of the bowel is affected in a similar manner to that in typhoid fever, and hence gives rise to a train of symptoms resembling those in the first form."

The question belongs entirely to the domain of etiology, and in the present state of etiological research it is of necessity difficult or quite impossible to decide it with certainty. In the first place there are no *à priori* objections to the views of Niemeyer and Wunderlich. In other well-characterized infectious diseases, besides the mild and abortive forms which are etiologically identical with the fully developed disease, we are familiar with lighter affections, which, though they offer many analogies with the above diseases, present some specific points of difference. Together with the perfect cases of cholera, lighter and lighter forms are met with till we come to the most trifling cholera diarrhœas, which, however, still depend upon the same infection as the severest cases; but besides these there is also a cholera nostras, which it is impossible sometimes to distinguish either by the symptoms or anatomical examination from the Asiatic cholera, but which is neither produced by the cholera poison nor can it ever produce this poison. In addition to the perfect variola, we have, on the one hand, the various forms of varioloid down to the cases of simple febris variolosa,[3] which can no longer be diagnosticated by their symptoms, but which etiologically are identical with severe variola; and, on the other

[1] Lehrbuch, Bd. I. 7. Aufl. p. 691 ff. [2] Eigenwärme. 2 Aufl. p. 290.

[3] Compare *Bierwirth*, über Febris variolosa sine variolis. Archiv der Heilkunde, 1872

hand, we have vaccina and varicella, which are essentially different diseases. Besides measles and scarlet fever, there exist as special affections the rubeolæ. With perfect cases of yellow fever there are light and abortive forms, but still due to the same infection; and, on the other hand, there is an epidemic icterus which is not dependent upon yellow fever infection.

Furthermore, it is evident that in cities like Basle, in which the typhoid poison has a wide distribution, attempts to solve this question will be in vain. In such places every so-called febris gastrica will be at once regarded as typhoid fever, and indeed usually with good reason. But whether now and then single cases do not occur, to which such a diagnosis does not apply, in the absence of pathognomonic symptoms, cannot be determined. Therefore the question can only be solved by observations at places where the typhoid fever seldom or never occurs.

I must confess that to me it seems to a certain degree plausible that such fevers, corresponding in their symptoms with the mildest forms of typhoid, but really essentially different diseases, should occur; and the reason for this lies partly in the fact that I have myself repeatedly remarked such cases under circumstances which, to say the least, rendered infection with the typhoid poison extremely improbable. Still, it must be admitted that, considering the manifold, obscure, and hidden ways in which the typhoid poison may spread, the utmost caution is required in judging of such cases.

DIAGNOSIS.

There is not a single symptom belonging to typhoid fever which can be characterized as pathognomonic; at the same time there is usually no difficulty in making a diagnosis in tolerably well-marked cases, provided each case is closely watched and subjected to careful examination. Of course, if we are called to see a case in which the disease has already reached an advanced stage and the patient is unable to give any account of himself, it will sometimes happen that an accurate diagnosis cannot possibly be made. Then again, there are cases in which peculiar surrounding circumstances render it very difficult to make a diagnosis or to avoid falling into error. Even in cases that are not well marked, the diagnosis may frequently be made without any difficulty; but there are now and then cases of

a very mild form of typhoid fever, in which only a doubtful diagnosis can be made, owing to the slight degree or absence of fever.

It is hardly necessary to state here that it will afford but little assistance in making the diagnosis of typhoid fever, and in distinguishing it from other diseases, to lay down a series of dogmatic rules which the unskilled physician will not know how to use rightly, and the skilled will not feel the need of. Our aim should rather be to separate the essential from the unessential, the necessary from the accidental, the thing of frequent occurrence from that which happens rarely,—in a word, rather to cultivate a knowledge of the connection between the different manifestations of the disease, than to burden the memory with mere facts. The safest protection against errors is in each case to make a thorough investigation and observe the course of the disease with great care.

The points, then, of greatest importance to us in making a diagnosis are, first, *the course of the disease:* the slow beginning with the prodromic stage; the gradual increase of the fever, its long duration as a continuous fever, and finally its change to a remittent type. Next in order come *the enlargement of the spleen*, *the abdominal symptoms*, and *the roseola*. Any one of these manifestations may be wanting, or may escape detection, and yet the disease be typhoid fever; the more of them that are present, the surer the diagnosis. It is hardly necessary to add that the enlargement of the spleen and the abdominal symptoms —even an exanthema resembling roseola—can also be due to other causes; consequently, in weighing the value of these manifestations, we should use a certain degree of circumspection. Of less diagnostic value is the detection of a catarrh of the finer bronchi. The *typhoid symptoms*, to which the chief importance was attached in former times, possess only a relative significance. If we have been able to exclude all other causes, the presence of the typhoid symptoms, in cases that come under our observation at an advanced stage, simply indicates that a comparatively high fever has been in progress for a certain length of time; they afford, however, no clue to the nature of the disease.

To make our diagnosis sure, we must institute a careful examination of the case, and exclude all other diseases which present, at least upon a superficial examination, a similar complex of symptoms. By omitting, for instance, to examine the chest, one might easily mistake a pneumonia, or even a phthisis florida, for typhoid fever. An acute miliary tuberculosis may under certain circumstances be confounded with typhoid. This would hardly happen in the cases which are characterized by well-marked brain symptoms; for the careful observer would not fail to notice that the brain manifestations were out of all proportion to the previously or already existing fever, and hence not to be attributed to it. On the other hand, the mistake might easily be made in those rarer cases of acute tuberculosis in which the disease runs its course without a meningitis, but with a high grade of febris continua, of long duration, and characterized by typhoid symptoms which are in reality due only to the fever. It is often difficult, where one is not familiar with the prevailing epidemic influences, to distinguish the disease from typhus fever. It may very well be impossible at the beginning of the disease to distinguish between the prodromic fever of small-pox or scarlet fever, or the commencement of an asthenic pneumonia and the early stage of a typhoid fever. As a rule, however, it soon becomes easy to distinguish between them. It is possible, too, to confound the disease with intermittent fever, pyæmia, puerperal fever, meningitis simplex and epidemica, endocarditis—and especially endocarditis ulcerosa—pericarditis, pleuritis, uræmia, etc. How to distinguish between them is a question to which the physician who is familiar with these diseases scarcely requires an answer. We would simply reply in a general way, that the more one believes in the possibility of error, the surer will he be to avoid mistakes.

Of subordinate value in making a diagnosis are those circumstances which render it probable *à priori* that the case is one of typhoid fever. During an extensive epidemic a physician would, very properly, be more disposed to make the diagnosis of typhoid fever than during times when the disease was not prevalent, or in places where it rarely made its appearance. When there is no evidence in the surrounding circumstances to

favor the idea of an infection with typhoid poison, the objective symptoms should be very clearly marked before we venture upon the diagnosis of typhoid fever; but if, on the other hand, the patient lives in a house in which there are other well-marked cases of the disease, we may, with a strong probability of truth in our favor, pronounce the malady as identical, etiologically, with typhoid fever, although the objective symptoms might not be well marked. Furthermore, we should not be so ready to adopt the diagnosis of typhoid fever in the case of an old man, of a person suffering from phthisis or heart disease, of a woman far advanced in pregnancy, or of a man who has already had typhoid fever—although it is *possible* for all these to have it—as in that of a young and previously healthy individual.

Finally, we may sometimes find a confirmation of the diagnosis in certain complications, or sequelæ, which are frequently met with in typhoid fever. Thus, for example, the symptom of nose-bleed possesses some diagnostic value; later in the disease we may have the important symptoms of intestinal hemorrhage, perforation, and to a certain extent the various pulmonary complications; then, as an additional confirmation, come the protracted convalescence, the long-continued weakness of body and mind, the falling out of the hair, etc. It is hardly necessary to state that these various phenomena must be weighed with caution with reference to their diagnostic value in each particular case. There are certain other circumstances which render the existence of typhoid fever improbable. For instance, we might mention in particular a fresh nasal catarrh as one of the things which—according to experience—is not likely to occur in typhoid fever. In fact I can only recall a single case of well-marked typhoid fever in which the attack was preceded by a pronounced nasal catarrh. Even in those cases which I had treated with iodine (more than 200 in all), I was not able to record more than a single instance in which a nasal catarrh made its appearance; the case was a very mild one, and the catarrh appeared only after the subsidence of the fever. Herpes labialis or facialis weighs against typhoid fever, although it is not—as will be seen further on—a reliable indication.

While it is an important matter that we should arrive at a

correct etiological diagnosis, it is also equally important that we should take into account the manifold differences observable in the different cases, and divide them into different groups according to the severity of the disease. In making this classification we shall not, it is true, subserve a scientific purpose, but rather a practical one, with the question of prognosis chiefly in view; consequently the determination of the limits will necessarily be more or less arbitrary.

The most important criterion of the severity of a case is the intensity and duration of the fever; and upon this basis we can readily divide all cases into the following groups, which have very nearly the same limits as those adopted by the majority of authors:—

The *mildest cases*, or the afebrile forms, are usually not counted. To this category belong the cases in which the temperature in the rectum never or rarely rises above 103° Fahr., and the duration of the fever does not exceed eight days. As such cases require simply dietetic treatment, they cannot be made use of to show statistically the value of different methods of treatment. On the other hand, it is clear that in determining certain other questions, those for example of an etiological nature, we can make as good use of these cases, when correctly diagnosticated, as of the typical ones.

The *mild cases* of typhoid fever are those in which the temperature in the rectum does not rise above 104.8° Fahr., and the duration of the fever does not exceed sixteen days.

The *severe cases* are those in which the temperature in the rectum repeatedly rises above 105° Fahr., and the fever does not cease before the twenty-first day.

Between the mild and the severe forms there are cases which may be designated as *moderately severe*. In these neither the severity nor the duration of the fever is sufficient to justify their being reckoned among the severe cases, and yet they exceed the limits of the mild forms.

There are a few other things to be taken into consideration besides the intensity and the duration of the fever. For instance, an attack of typhoid fever with a temperature not exceeding 104.8° Fahr., may be a very dangerous disease, and

even terminate fatally in the case of an old man, or a hard drinker, or an asthmatic. So, too, an otherwise mild or a moderately severe attack may be accompanied by complications and sequelæ of a character dangerous to life. Among the severe cases, then, we must reckon, first, all those which terminate in death, and next, all those in which, from any cause whatsoever, life appears to be seriously threatened.

Many cases can be more conveniently analysed by adopting a still more simple basis of classification, which refers only to the duration of the fever and disregards the intensity and all other phenomena. Thus, according to Jürgensen, all cases are slight which show no fever after the sixteenth day, and all are severe where the fever continues a longer time. Such a classification has one great advantage that it binds one down to a definite number, and is sure to allow no room for the play of individual notions. It is true, a case might occur in which the fever lasted from three to four weeks, but was so mild in character, and the other symptoms of the disease were so insignificant that there was no occasion for anxiety or the use of medicines; in such an instance it would neither accord with the usages of speech nor the general aim of statistics to reckon it among the severe cases simply because it was somewhat more protracted. There are good, practical reasons, however, for such a classification into *cases of short* and *cases of long duration.*

In compiling statistics that are designed to show the favorable results obtained by this or that method of treatment, it will be necessary to follow the plan adopted by Jürgensen, and in the hospital of Basle, where the fatal cases of typhoid fever included all the patients that had been treated for typhoid and had subsequently died in hospital. It might be desirable to inquire whether such patients really died of typhoid, including under this name its complications and sequelæ, or whether death had been induced by some disease in no way connected with typhoid, such as an old phthisis, after complete recovery from typhoid, or perhaps from an accident, such as falling from the window, or something of the sort. In these cases there might be a broad difference between the views taken of these facts, and it would be doubtful whether statistics would have any positive value. It matters not what method of classification is adopted: many deaths will be referred to typhoid which are not due to it at all, or only in part; but there is a simple way of avoiding error, which consists in giving a short statement embracing the history of each fatal case.

TERMINATION AND PROGNOSIS.

Typhoid fever was considered by the older physicians as the disease which, more than all others, mocked medical foresight. They laid down as the principal rule in prognosis: "Spera infestis, metue secundis," and thereby intimated that any prognosis whatever was practically impossible. And, indeed, in

such a Protean disease, the elements upon which the prognosis depends are extraordinarily manifold, and therefore it belongs among the more difficult problems, to the best possible solution of which the accurate estimate of very numerous relations is essential. Moreover, it must be again admitted that a typhoid patient, even under the most favorable circumstances, is, of course, in greater danger than a healthy man, since, even in the lightest, or in those cases which seem to be quite ended, some unfortunate event, for example, perforation of the intestine, may still occur. But the physician should not be a prophet; he should not anticipate the unusual, but only the usual. And in this respect the better understanding of the connection of the symptoms, which has been recently gained, has so increased the certainty of the prognosis in typhoid fever, that we, in direct opposition to the views of the older physicians, can maintain that among the dangerous acute diseases there is scarcely another in which the prognosis can be made with so high a degree of probability as in typhoid fever.

In the consideration of the termination and prognosis we shall at first confine ourselves to those cases which run their course without notable complications. The frequency of the different complications and sequelæ, and the consequent changes which the prognosis undergoes, will be considered afterwards.

Death may occur in any stage of the disease; in cases not specially complicated it happens by far the most frequently toward the end of the third or in the beginning of the fourth week; it rarely happens as early as the second week in uncomplicated cases, and I do not remember ever to have observed a case of death in the first week of typhoid fever; still, a few such cases have been reported by other observers. However, death may occur after the fourth week, without special complications being present, beyond the more or less direct results of the ordinary lesions.

The question of the immediate *cause of death* in uncomplicated cases is of the greatest importance. We consider intestinal hemorrhage, perforation of the intestine, and the like, although they represent in a certain measure only the results of alterations that ordinarily occur in typhoid fever, as complica-

tions and sequelæ, and shall not here consider the cases in which they occur as immediate cause of death. We can then say, that in all typhoid patients who die without complications, the immediate cause of death lies in the *fever and its consequences*. The patients die either from *weakness of the heart*, caused by the rise of temperature, that is, *paralysis of the heart*, with its immediate consequences, or from *paralysis of the brain*, which is likewise dependent upon the rise of temperature. We can here anticipate and add that many of the complications and sequelæ which cause the death of other patients are more or less dependent upon the fever.

Hence it appears that the *character of the fever, more than anything else, is indicative for the prognosis of typhoid fever*. But here a second point requires attention. Some individuals can bear severe, long-continued fever, while others succumb promptly to a lighter one. In such a case, therefore, the *behavior of the individual in presence of the fever* is equally important for the prognosis.

Next in importance for the prognosis is the *absolute height of the temperature*. This is already shown by statistics. I have arranged the histories of more than 400 cases in the hospital at Basle, during the time when no consistent antipyretic treatment was carried on, with reference only to the maximum axillary temperature observed in the hospital. Of those patients in whom 104° or more was not observed, 9.6 per cent. died; of those in whom 104° was reached and passed, 29.1 per cent.; finally, of those in whose axilla the temperature rose to 105.8° and over, more than half died.

The result would be still more striking if we could study the individual cases more closely. The cases of death with relatively low temperature were caused in part by sequelæ, such as perforation of the intestine, apoplexy during convalescence; in part they occurred in individuals with exceptionally slight power of resistance, such as habitual drinkers, consumptives, emphysematous or very old people; and finally, in part they occurred in cases which were nearly moribund when brought into the hospital, and of whose earlier temperature nothing was known. Among the cases of death with higher temperature were, on the other hand, many in which death occurred, without especial complications, as a result of the fever.

Fiedler also (Deutsches Archiv für klin. Medicin. Bd. I. page 534) found in

the cases observed by him that of those patients whose temperature had risen to or exceeded 106°, more than half died. According to Wunderlich (Eigenwärme, page 300) at 106.16° the danger is considerable, at 107.06° the deaths are almost twice as numerous as the recoveries, and at 107.24° and over, recovery is rare.

Still more important for the prognosis than the absolute height of the temperature is the *duration of the fever*, and especially the *duration of the continued fever*. The danger to the patient increases with every additional day which the fever lasts, for with every day the effects of the rise of temperature are augmented; and for this reason the duration of the fever, *cæteris paribus*, indicates the severity and with it the danger of the cases.

Only when the disease is completely ended can we determine with full certainty the maximum reached by the temperature, and the length of the duration of the fever, and consequently the knowledge of the dependence of the prognosis upon the height and duration of the rise of temperature would be a doubtful gain, if the material for the opinion were obtained only after the termination of the disease. The problem should rather be this, to determine at the beginning of the attack, or at least as early as possible, what height and what duration of the rise of temperature are to be expected. It is never possible to determine this with absolute certainty; for in all cases unforeseen relapses, drawbacks, and the like can occur. But there are still certain indications, which, in many cases, allow the height and duration of the fever to be predicted with great probability in the earlier stages.

The *height to which the temperature rises at the end of the first week* indicates in a measure the height of the elevation of temperature which is to be expected during the course of the disease; as a rule, in the subsequent course of uncomplicated cases, the temperature rises but little above this point.

The beginning of the attack furnishes a fair indication for the duration of the fever which is to be expected. The more sudden the appearance of the disease, and the more rapid the rise of temperature in the beginning of the first week, so much the more should one expect in general a short or even abortive attack. Further. the duration of the fever is in general so

much the shorter, as the temperature is less high toward the end of the first week. And finally, observation of the *daily fluctuations of temperature* furnishes a very important indication for the prognosis. In general, the prognosis is more favorable as the daily fluctuations are greater. This depends in great part upon the fact that a fever which shows notable remissions is much more easily borne than one which remains nearly at the same height. In part, also, the favorable indication of great morning remissions depends upon the circumstance that they allow us to presuppose less obstinacy and shorter duration of the fever. A fever in which, at the end of the first week, and during the second, the usual daily fluctuations are but slightly marked; in which, for example, the difference between the maximum and minimum, leaving out any exceptional temporary excessive increases, is only 0.9° or less, is much more rapidly effective in injuring the organism, and, besides, we may expect it to last longer and to manifest a greater obstinacy, so that a much greater resistance to therapeutical influences is to be expected. As soon as the morning remissions become greater, and exceed the amount of the usual daily fluctuations, the danger dependent upon the fever itself ends, and therefore the early appearance of great morning remissions has a very favorable significance.

Fiedler saw, with one single exception, all patients die whose temperature in the morning rose to or surpassed 106.25°. Of those whose temperature in the morning rose to 105.44°, even if only on one day, more than half died.

Even a single unusually marked *remission* of the fever has a favorable signification, inasmuch as it indicates that the fever is less obstinate. And in this connection the effectiveness of antipyretic therapeutical agents is especially of great importance. The more the temperature is reduced by cold baths, and the longer the interval before it rises again to its former height, so much the less obstinate is the fever, and so much the milder course is to be expected. Very important, also, in this connection, is the amount and duration of the remission caused by a certain dose of quinine; and quinine is therefore, in a certain measure, a reagent by which the prognosis can be in great part

determined. It gives us a certain sense of security when we know that we can reduce the temperature at will, whenever it may seem necessary to do so.

That a violent intestinal hemorrhage or collapse, in consequence of perforation of the intestine, is not to be considered favorable, because they cause a great reduction of temperature, is of course understood, and is not prejudicial to the rule; even in these cases the reduction of temperature has sometimes evidently a favorable effect; but these occurrences are in themselves so bad, that in contrast to them such a temporary advantage cannot be taken into consideration.

Finally, the prognosis is dependent, to a considerable degree, upon the kind of *treatment of the fever*. He who depends entirely upon observation and critical examination of the fever, and upon the antipyretic treatment, ought to give in his cases a considerably more favorable prognosis than he who does not bother himself about modern progress.

Of decisive influence upon the prognosis is, moreover, the individuality of the patient, and especially his power of resistance to the effects of elevation of temperature. Individual patients show in this respect very great differences. We shall consider in order the individual relations which principally deserve attention, after having described the most important signs by which the resistance of the individual in each case can be determined.

As the weakness or paralysis of the heart is the most frequent immediate cause of death, so is the *condition of the heart's activity*[1] one of the most important prognostic signs; consequently observation of the pulse is of even greater significance than the observation of the temperature for the prognosis of some cases. So long as the pulse is, in a measure, strong, and its frequency only moderately increased, no immediate danger exists on this side, even when the constant elevation of temperature is very considerable. But it is to be well remembered that, if the necessary precautionary measures have been neglected, the scene may suddenly change, and it may then be too late. If, on the contrary, the frequency of the pulse has reached a considerable degree, if it amounts to 120 or more, this is ordinarily an indica-

[1] Compare Febrile Disturbances of Circulation. Deutsches Archiv für klin. Med. Vol. I. page 461.

tion that a weakness of the heart, threatening danger, is already present, or is impending. Such an excessive frequency of the pulse causes less anxiety when it occurs in an individual not yet full grown, or in a nervous woman, or is only temporary, and especially when a particular cause is known. It causes much anxiety if, while the pulse is weaker, there are other symptoms of weakness of the heart, such as hypostases in the lungs, slight cyanosis, symptoms of collapse, excessive differences between the temperature of the interior and the surface, or œdema of the lungs.

From a collection of histories of cases in the hospital at Basle, which, taken all together, show a mortality of from 16 to 17 per cent., I have averaged those in which it had been observed that the frequency of the pulse rose to and above 120. Of 63 such cases 40 died, that is, nearly two-thirds. Among these 63 were 37 in whom the frequency of the pulse did not rise above 140; of these 19 died, about half; in 26 cases the frequency of the pulse rose to more than 140; of these 21 died, about four-fifths. In 12 cases it rose above 150; 11 of these died. Of those in which the pulse rose to 160 the only case that recovered was one of a girl 21 years old, suffering from an imperfectly developed typhoid. This excessive frequency existed only on one evening, when the temperature in the axilla reached, for the first time, 104.9°; on the following evening, with the same temperature, the frequency of the pulse mounted only to 110.

In other febrile diseases also, the excessive increase in frequency of the pulse has a bad prognostic significance, but by no means to the same degree as in typhoid fever. Of the cases of pneumonia, in the hospital at Basle, of 55 patients whose pulse exceeded 120, 12 died; and of 17 patients, in whom it rose above 140, 7 died.[1]

Also, with regard to the *functions of the brain*, different individuals behave very differently in the course of the fever. In many patients the graver disturbances of the third degree are caused by a moderate fever of moderate duration, while others endure a severer fever for a longer time without suffering from this degree of disturbance. This difference in the behavior of different individuals, in the presence of elevation of temperature, is certainly very remarkable, and is the reason why the dependence of the physical lesions upon the rise of temperature,

[1] *S. Fismer.* The Results of Cold-Water Treatment of Acute Croupous Pneumonia in the Hospital at Basle. Dissertation, published in the Deutsches Archiv für Klin Med., vol. XI., 1873, page 391.

which is so very evident to the unprejudiced observer, was for so long a time unrecognized. But we must remember that similar, and even greater, differences are observed in other influences which affect the functions of the brain, especially in the action of alcohol and narcotic poisons. Many individual causes which have an influence on the degree of the brain's power of resistance will be noted further on.

In general, we may assume that the more profound disturbances of the function of the brain occur especially in the gravest cases; and that the danger increases rapidly in proportion to the degree of psychical disturbance.

Among the typhoid patients treated in the hospital at Basle, in the years 1865–1868, there were 983 in whom the disease ran its course without any specially noteworthy brain symptoms; of these 34 died, about 3½ per cent.

Slight delirium, excitement of low grade, lasting for only a short time, or appearing only during the night, occurred in 191 cases, of which 38, say 19.8 per cent., died. Well-marked delirium occurred in 176 cases, of which 96, or 54 per cent., died.

In part of these the delirium was continuous in character and well marked, or else occurred at intervals in the form of violent fits of excitement, while in others it was of the muttering variety.

Stupor and coma were present in 43 cases, of which 30, or 70 per cent., died.

All kinds of special brain symptoms which are not due to the fever alone are in a high degree prejudicial to the patient's chances, for they indicate some unusual cause of disturbance, often a grave lesion within the cranium. Especially unfavorable are meningitic symptoms, apoplectic accidents, epileptiform or general convulsions. Less dangerous are melancholic conditions, or other more marked forms of mental disease, which appear in the course of the disease or during convalescence. But even symptoms, which in healthy people are explained as hysterical, render the prognosis considerably more unfavorable if they appear during the height of a moderately grave attack of typhoid fever.

In addition to the different degrees of ordinary disturbance of the functions of the brain above mentioned, there occurred 5 cases of *trismus*, of which 4 died. Of 6 cases of *eclampsia*, or *general convulsions*, 5 died. In 14 cases *dementia* or *melancholia* was developed; of these, 3 died.

Notwithstanding that the kind and degree of brain symptoms are undoubtedly of especial significance for the prognosis, we must guard against attaching too much weight to them to the neglect of other influences. The uncertainty of the prognosis, which the older physicians insisted upon, depended in great part upon the circumstance that they judged of the gravity and danger of any case, as do still the laity, too much according to the appearance of "typhoid symptoms;" for these indeed is the saying true: Spera infestis, metue secundis.

INDIVIDUAL PECULIARITIES.

We have already been obliged frequently to refer to the fact that the individual peculiarities of a patient exercise an extraordinary influence upon the course and character of the disease, and that the prognosis in particular depends to a great extent upon these peculiarities.

Much that pertains to this subject is entirely or in great part unknown to us; but still experience has accumulated a series of facts which are of value to us in our practice.[1]

The influence of age makes itself felt in a very striking manner. It may be laid down as a rule, that the elevation of temperature usually reaches a higher degree in young persons than in old, but that young persons bear the elevation of temperature much better than older ones. The latter circumstance is of such weight that, in spite of the higher curves of temperature in young subjects, the prognosis is in general the more favorable, the younger the patient.

With *children* especially (leaving out the first year of life) the prognosis is decidedly more favorable than with adults. This appears to rest partly upon the fact that the really severe cases are comparatively rare in childhood; that the changes taking place in the intestine more rarely proceed to extensive necrosis and ulceration, and that severe complications and sequelæ less frequently occur; partly, however, upon the fact that in

[1] Comp. Deutsches Archiv für klin. Medicin. Bd. I. 1866. S. 581 ff.

children a considerable and continuous elevation of temperature is less apt to induce paralysis of the heart.

According to Friedrich,[1] there were, among 16,084 children treated in the Children's Hospital at Dresden, 275 cases of typhoid fever, of whom 31, or about 11 per cent., died.

According to French statistics there occurred, out of 2,282 cases in individuals under 15 years of age, 256 deaths, or 11.2 per cent.; out of 7,692 cases, in individuals over 15 years of age, 1,411 deaths, or 18.3 per cent. (*Murchison*, l.c. p. 532.)

The only case which I saw recover after the temperature had risen repeatedly to 107.5° Fahr., occurred in a girl 14 years of age.

With *elderly people* the elevation of temperature is ordinarily less marked during the whole course of the attack; and, corresponding with this, the severe disturbances of the nervous system are less often seen.

On the other hand, paralysis of the heart is more likely to occur, and the mortality is also far greater than with younger persons. From the fortieth year the prognosis begins to be markedly more unfavorable.

Among 1,743 typhoid cases, treated in the hospital at Basle, in the years 1865 to 1870, inclusive, there were 130 who were more than 40 years old. Of these, 39, or 30 per cent., died, while the mortality among the cases under 40 amounted only to 11.8 per cent.

Among the cases of typhoid fever in individuals over 40 years of age, which Uhle[2] has collected, more than half proved fatal.

In the female *sex* the mortality appears to be somewhat greater than in the male.

In the years 1865 to 1870, inclusive, there were treated in the hospital at Basle 999 men, of whom 120 died, = 12 per cent., and 744 women, of whom 110 died, = 14.8 per cent.

In the London Fever Hospital the mortality from typhoid fever during 10 years was 17.7 per cent. for men, and 18.9 per cent. for women. (*Murchison*, l.c. p. 530.)

Of notable influence upon the mode of attack and the course of typhoid fever, is likewise the *constitution* of the patient. Heretofore, however, the peculiarities which make up the par-

[1] Der Abdominaltyphus der Kinder. Dresden, 1856.

[2] Archiv für physiologische Heilkunde. 1859. S. 76 ff.

ticular constitution of a man have been too little known for us to give more than a few hints concerning their influence.

There are exceedingly *sensitive*, and, on the other hand, exceedingly *torpid individuals*. With the former all the subjective symptoms of disease are very pronounced. They feel unwell sooner, and become sooner unfit for work, and obliged to take to their beds. Cerebral symptoms appear early, and often are very violent. Active and even furious delirium is more frequently present. The pulse frequency is more apt to reach an unusual height. In consideration of this readier excitability, the same significance is not to be attributed to these symptoms, as in the case of other individuals. Phlegmatic persons are in every way less easily excited. They notice, comparatively late, that they are ill, do not take to bed during the first week, even when the fever is considerable, and, with a mild course of the disease, often remain at work during the second week. Cerebral symptoms do not appear till late, and consist more frequently of apathy and simple weakening of the functions. When delirium occurs, it is principally in the form of quiet muttering. The pulse frequency does not reach so high a degree. In judging of the symptoms in these patients, we must take into consideration their individual peculiarities. It is better to attach greater significance to their symptoms, for the individual capability of resistance does not always increase in proportion to the diminution of the capacity to receive impressions.

At least a part of the cases of the so-called *typhus ambulatorius* should properly be mentioned in this connection, inasmuch as the cases referred to occur in individuals who appear to be remarkably little affected by the disease. Another part, however, includes, as Jürgensen supposes, cases of undeveloped typhoid fever, which often, through errors of diet and an improper mode of life, are aggravated and protracted in their course. Especially in the mild cases of typhoid, in the stricter sense of the term, does it happen that individuals, even though not particularly phlegmatic, go about during the entire second week, until an observation of the temperature is made, and perhaps found to be 104° Fahr.

Of great influence upon the course of the disease is the cir-

cumstance whether the patient be *fat* or *lean*. It is a well established fact, that when very corpulent individuals are attacked with typhoid fever, the prognosis is very unfavorable, and the popular belief that "stout" persons are more endangered by the disease than weak ones, is based upon truth, —if by stout individuals be understood such as possess a considerable panniculus adiposus. Recently, Roeser,[1] of Bartenstein, has brought forward prominently the fact, that typhoid and other febrile diseases often run a particularly unfavorable course in very corpulent persons, who, at an early date, manifest those symptoms which we term weakness or paralysis of the heart. If we inquire concerning the causes which explain the unfavorable course of the disease in corpulent individuals, we find that a variety of circumstances must be taken into consideration. In the first place, experience shows that in these cases the temperature generally reaches a higher degree. Moreover, fat persons possess a slighter resistance to elevation of temperature; the parenchymatous degenerations of the organs appear earlier and are more developed,[2] and the heart especially is less able to hold out for any length of time. Finally, we must also bear in mind that treatment is much less effective in corpulent persons, owing to the fact that the thick cushion of fat prevents in a great degree the internal cooling of the body.[3]

Typhoid fever is best endured by lean, though at the same time muscular persons.[4] But even in the case of ill-nourished anæmic or chlorotic individuals, the prognosis is far more favorable than in the case of the corpulent. Of 53 patients in the hospital at Basle, who would have been called extremely ill-nourished, anæmic, or chlorotic, 7 died, or about 13 per cent.,

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[1] *Betz*, Memorabilien. 1860. 3.

[2] Compare *Wunderlich*, Archiv der Heilkunde. 1863. S. 154.—*Liebermeister*, Beiträge zur patholog. Anatomie und Klinik der Leberkrankheiten. Tübingen, 1864. S. 340.

[3] Compare Deutsches Archiv für klin. Medicin. Bd. X. 1872. S. 436 ff.

[4] Even Galen teaches that fevers of a putrid character do not occur as readily in lean persons as in the plethoric and corpulent. Methodus Medendi. IX. 3. Ed. Kühn. X. p. 606 sq.

while the average mortality at that time amounted to about 15 per cent.

A striking diminution of the power of resistance to elevation of temperature appears in the case of individuals who imbibe habitually large quantities of spirits, particularly brandy. In the next place it is to be noted that with drunkards who suffer from typhoid fever, the temperature, on the average, runs lower than with other individuals. In spite of this, however, the functional disturbances, which depend upon the rise of temperature, are equally developed, and even generally severer and more dangerous than usual. The parenchymatous degeneration of the organs, which in drunkards often exists already to a moderate degree, is especially apt to reach more rapidly a dangerous degree of development. Accordingly, we can understand how it happens that death, in the case of drunkards, occurs so often from paralysis of the heart. The cerebral symptoms generally appear before the temperature has reached a high degree, and they may become violent in character. With the slow rise of temperature peculiar to typhoid fever, the cerebral symptoms more rarely assume the well developed form of delirium potatorum, than in diseases with a more rapid elevation of temperature. Still, in the great restlessness of the patients, and in the tendency to violence, we frequently find traits at least which in a measure suggest this form. Of 19 notorious drunkards in the hospital at Basle, 7 died, or more than a third.

In persons who are attacked by typhoid fever *for the second time*, the disease appears, in general, to possess rather a milder character.

The danger is very great when typhoid fever appears during *pregnancy*.

In 18 typhoid fever cases of pregnant women in the hospital at Basle, which occurred from 1865 until 1868, among a total of 1,420 cases (with an average mortality of 15 per cent.) there resulted in 15 cases abortion or premature birth. (There was a birth at full term of a living child in one of the cases that terminated fatally.) Considerable hemorrhage usually occurred. In the 3 cases that did not abort—in whom the disease followed a severe though favorable course—the duration of pregnancy before the attack amounted to 1, 4, and 5 months. Of those who aborted or gave birth, 6 died, or a third of all the pregnant cases. The treatment is per-

haps of influence on the prognosis. In the years 1869–1872, during which the antipyretic treatment was carried on systematically, there occurred 5 more cases of abortion or premature birth, of which only 1 case proved fatal.

Griesinger observed typhoid fever in 5 pregnant women, all of whom aborted, and 3 of whom died.

The prognosis is also unfavorable where typhoid fever develops itself during childbed or a short time afterwards.

Of 7 women who had given birth from 4 days to 10 weeks before their attack, 3 died, or almost one-half. With 2 of the patients the fever ran a mild course (in the one case the birth took place 4 days, in the other 10 weeks previously).

Those who suffer from serious *chronic diseases*, if attacked, as is rarely the case, by typhoid fever, are in greater danger than healthy persons.

Diseases of the heart are especially unfavorable on account of the greater danger of cardiac paralysis.

Of 6 cases of valvular disease which were treated in the years 1865 to 1868, 3 died. On the contrary, 3 cases of mitral insufficiency, which were treated in the years 1870 and 1872 on the antipyretic plan, all recovered.

Typhoid cases which suffer simultaneously from emphysema of the lungs exhibit many peculiarities. The elevation of temperature in these cases is notably less; and corresponding to this the parenchymatous degenerations of the organs are found to be of lesser intensity, and often but slightly perceptible, with the sole exception of the heart, which, if the emphysema has existed for a long time, may be considered as having already undergone degeneration, and particularly the right ventricle. These cases are particularly liable to paralysis of the heart.

Individuals with *chronic catarrh of the smaller bronchi*, although no emphysema may be present, also run great danger when taken sick with typhoid fever. The same is true of patients with tracheal stenosis, resulting from struma, and also of patients with pulmonary phthisis.

Of twenty-three cases, which previous to the commencement of typhoid fever had suffered from pulmonary phthisis, only six were dismissed at the termination of the fever. The seventeen others, or almost three-quarters, died either from typhoid fever, or subsequently from their phthisis, which was notably aggravated thereby.

Individuals with *diabetes mellitus*, when attacked by typhoid fever, exhibit, according to the observations of Griesinger and Bamberger, the peculiarity that the temperature does not rise so high and the disturbances depending upon the elevation of temperature are but slightly developed. The danger, however, appears to be very great.

COMPLICATIONS AND SEQUELÆ.

Griesinger, loc. cit.—*Hoffmann*, loc. cit.—*D. Betke*, Die Complicationen des Abdominaltyphus. Statistische Zusammenstellung, nach den Beobachtungen im Spital zu Basel in den Jahren 1865–1868. Dissertation. 1870. Deutsche Klinik, 1870. Nr. 42 ff.

The complications and *sequelæ* of typhoid fever are more numerous and varied than those of any other disease. To enter upon their consideration fully, and in an exhaustive manner, would involve the necessity of our going over the greater part of the entire field of Pathology. This cannot be undertaken in such a work as the present. We shall, therefore, confine ourselves to studying in detail those complications only which stand in an intimate relation to typhoid fever and are peculiar thereto, glancing more cursorily at such as are common to this and to other diseases.

One class of the complications and sequelæ of typhoid fever is intimately related to the pathological changes ordinarily incident to the disease, and represents only a further development and excessive spread of the same. So, for instance, the *primary lesions* of the intestinal canal are followed by hemorrhage from the bowels, perforations, serpiginous ulcers, or peritonitis without perforation. The *parenchymatous degeneration* incident to the disease may be followed by rupture of muscles, muscular abscess, parotitis, nephritis, various diseases of the nervous system, the hemorrhagic diathesis, etc. ; while the characteristic degeneration and weakness of the heart frequently lead to hypostatic congestion, œdema, thrombosis, embolism, infarction, and their results.

Another class of the complications stands in a less intimate

relation to the original disease, representing rather *accidental occurrences* following in its train. Such are attacks of pneumonia, pleurisy, erysipelas, phlegmonous inflammations, diphtheritic processes, etc.

A careful study of the complications and sequelæ under consideration, prosecuted both at the bedside and on the cadaver, cannot fail to convince the observer that in all organs, without exception, the powers of resistance to evil are reduced to their minimum, and that there exists a *peculiar tendency to the disintegration of tissue*. Thus we see that solutions of continuity heal but tardily, and even show a disposition to extend; such being the case with the serpiginous ulcers of the bowels, as well as with various accidental losses of tissue. This tendency to the disintegration of tissue shows itself strikingly in the fact that under these circumstances the most insignificant injuries, which with a healthy condition of the parts would cause but trifling inconvenience, result disastrously, often terminating in necrosis and gangrene; as, for example, where the pressure of the teeth causes gangrene of the tongue, or where even the most carefully guarded pressure of the bed produces extensive, deep, and destructive bed-sores. In other instances, various organs of the body display a special readiness to take on inflammatory action, as, in the case of the lungs, the serous or mucous membranes, the skin, the lymphatic glands, etc.

This tendency to disintegration is essentially dependent on the elevation of temperature. Surgeons have always known that wounds will heal badly if the wounded man contracts typhoid fever or any other severe febrile disease. It is an easy matter to prove, in any typhoid case, that bed-sores show no disposition to heal or to cease spreading, until the fever has ceased, or, at least, until long intermissions have been established. I have repeatedly seen patients having a soft chancre seized with typhoid fever, in whom the ulcer spread rapidly and caused extensive gangrene. In one woman the extensive gangrenous process thus originated caused death; in a man, amputation of the penis was required; in another case the gangrene limited itself on the cessation of fever; but a relapse taking place while a bubo was open, gangrene again set in and involved the entire scrotum. I have also, during an attack of typhoid fever, seen old fistulous tracts, dependent on former disease of the bone reopen, and necrosis of the bone supervene, accompanied by profuse ichorous discharge.

In addition to the direct influence of an elevated temperature, however, in producing this tendency to disintegration, there is no doubt that defective nutrition, and in some cases defective circulation of the blood, from weakness of the heart's action, are also inducing causes.

As regards all disturbances, directly or indirectly dependent on an elevation of temperature, it would be supposed, *à priori*, that antipyretic treatment, which succeeds permanently or temporarily in lowering the temperature, would result in diminishing the frequency of such disturbances. As far as our data reach, we shall endeavor to compare the frequency of these complications and sequelæ, as between cases treated on the expectant plan and those treated by antipyretic means.

In the following pages the individual affections to be considered will be grouped not so much with reference to their dependence on the original malady, as with regard to the systems or organs involved.

I. *Digestive Apparatus.*

Hemorrhage from the bowels is of frequent occurrence in typhoid fever. Sometimes the dejections are merely streaked with blood, or contain a little bloody mucus; in other cases large quantities of blood, amounting to from one to several quarts, are discharged. If the blood is promptly expelled from the bowels, it is of a dark-red color and of syrupy consistence or loosely clotted; if it has been retained for some time, it assumes a brown or dark-green color, and a tough, tarry consistency.

Taking the statistics of the hospital at Basle, if we include the lighter hemorrhages (throwing out those only where mere traces of blood were discovered), we find that among 1,743 cases of typhoid fever, hemorrhage from the bowels occurred 127 times, or in $7\frac{3}{10}$ per cent. The proportion amongst men was 5 per cent. of the cases attacked; that amongst women, 10. Forty-nine of the 127 cases in which hemorrhage was present died, that is to say, $38\frac{6}{10}$ per cent.

Amongst 81 cases of intestinal hemorrhage, in which the chronology was carefully kept, 7 took place during the first week, 33 during the second, 19 during the third, 14 during the fourth, and 8 at a still later period. Other observers place the average period for the occurrence of hemorrhage somewhat later than this.

Griesinger has observed 32 cases of hemorrhage in 600 typhoid fever patients, or $5\frac{3}{10}$ per cent.; Louis found them in $5\frac{9}{10}$ per cent., though the milder cases seem not to have been included in his estimates. Of the 32 cases reported by Griesinger, 10 died, 7 of them within four days of the first hemorrhage. During the first week of the disease no instance of hemorrhage occurred; during the second week (chiefly toward the end of it) 10; during the third and fourth weeks, each 8; in the fifth, 2, and in the sixth, 3.

Anatomical investigation has demonstrated that during the earlier period of the disease, until the end of the second week, the hemorrhages are caused by the rupture of vessels within an area of strikingly loose, relaxed, and highly vascular infiltration; that during the third and fourth weeks the hemorrhages are due to the separation of rather superficial sloughs; and that

at later periods they depend on the destructive action of the serpiginous ulcers. Sometimes the escape of blood from the bowels is only one among many evidences of the existence of the hemorrhagic diathesis.

In case of the escape of a large amount of blood into the cavity of the intestine, symptoms of more or less complete collapse will ensue; the face suddenly grows pale, the pulse weak, the extremities cold, while the temperature of the interior of the body sinks several degrees. If the blood is not discharged from the bowels, its accumulation within their cavity may destroy the ordinary tympanitic percussion sound over portions of the intestinal tract. By these symptoms one may, with a greater or less degree of certainty, diagnosticate a concealed intestinal hemorrhage. The lowering of temperature that occurs under these circumstances has the same effect on the condition of the patient as would follow any other marked remission of fever. The most striking effect noticed is often in the diminution or disappearance of serious brain symptoms; the frequency of the pulse is also sometimes lowered. This favorable change, however, is usually but transitory; before the expiration of twenty-four hours the temperature ordinarily begins to rise again and the disease resumes its usual course, with the further disadvantage to the patient, that, owing to loss of blood, his powers of resistance are notably diminished and the danger of cardiac paralysis is not a little increased.

Opinions differ as to the *prognostic significance* of intestinal hemorrhage in typhoid fever. The majority of physicians consider any considerable amount of such hemorrhage as an ill omen; and there is certainly no little evidence in support of this opinion. Of our own cases, $38\frac{6}{10}$ per cent. died, whereas the mortality among those without hemorrhage was only 11 per cent. We are therefore all the more surprised to find individual observers, prominent among whom are Graves and Trousseau (l. c. p. 223 *et seq.*), advancing the opinion that this complication is to be considered as of favorable import. This declaration, on the part of two men of such extensive experience, is entitled to careful consideration, even though it is at variance with our own conclusions. We must at least ask ourselves what can have given

rise to such a conflict of opinion? And first of all we will admit that these hemorrhages, in reality, have not as dangerous a significance as was formerly often thought, and as is still believed by the laity, who always become demoralized at the sight of blood. It is but very rarely that a patient dies as the direct result of the hemorrhage, or during the collapse that immediately follows it. And, after all, 78 out of 127, or by far the greater number of our own cases, recovered. Furthermore, we must not forget the evident amelioration of many symptoms of the disease that often follows a hemorrhage and the accompanying fall of temperature, and which, in some instances, when the fever is already near its end, may usher in a permanent improvement. Finally, our statistics, it must be confessed, are not quite as conclusive as they at first sight appear; for intestinal hemorrhages occur most frequently in the gravest cases of the disease, in which the mortality without hemorrhage would still be highest. In some fatal cases the hemorrhage is in no way responsible for the result; in many others, however, it apparently contributes to the production of cardiac paralysis. While, therefore, intestinal hemorrhage must be regarded, on the whole, as affecting the prognosis unfavorably, yet each individual case must be judged on its own merits. A slight discharge of blood, in a case already recognized as grave, adds nothing to its gravity, except in so far as it excites the fear of a more copious return of the same.

A copious hemorrhage early in the disease is highly unfavorable, for if the continued fever persists long, there is every reason to fear that the patient will succumb, the more so as the hemorrhage, if considerable, contra-indicates the use of one of the most valuable therapeutic agents in such cases, to wit, cold baths.

An equally free flow of blood at a later period, at the end of the third or during the fourth week, though not without danger, is far less alarming; for one may now hope that the patient will no more be required to resist the influence of a long-continued high temperature: under some circumstances, even the marked remission following loss of blood may prove to be the favorable turning-point in the disease.

It has been asserted repeatedly, that hemorrhage from the

bowels is of *more frequent occurrence since the use of cold baths* in the treatment of typhoid fever. The anæmia of the skin, it is assumed, must produce a determination of blood to the internal organs, and thus favor hemorrhage. The question, however, can only be answered by experience. Under my own observation the number of cases treated before the introduction of cold baths was 861, among which occurred 72 hemorrhages, or $8\frac{4}{10}$ per cent. After the introduction of the treatment by cold baths we had 882 cases, with 55 hemorrhages, or $6\frac{2}{10}$ per cent. The *frequency of intestinal hemorrhage has, therefore, materially diminished under the cold-water treatment.* The number of cases observed is, I think, large enough to settle the question; the more so as the period of cold-water treatment has extended over something more than four years, and as, during this time, the histories of cases have been even more carefully kept than before.

In the hospital at Basle, during the year 1872, Immermann reports only six cases of hemorrhage among 146 typhoid fever patients treated with cold baths—a percentage of $4\frac{1}{10}$.

Wunderlich, junior,[1] reports 253 cases of typhoid fever at the Leipzig clinic, with 18 hemorrhages ($7\frac{1}{10}$ per cent.). One hundred and fifty-five of these were treated with cold baths, and gave 16 of the hemorrhages ($10\frac{3}{10}$ per cent.). In spite of these statistics, Wunderlich is inclined to believe that the influence of the baths in inducing hemorrhage is more apparent than real, inasmuch as they occurred in groups, at certain times, with long intervals of complete immunity, thus making it probable that accidental causes conspired in their production.

Perforations of the intestine are most frequent during the third to the fifth week of the disease, though they may occur still later. The earlier perforations take place at the time of, or soon after, the throwing off of sloughs from the ulcerated portions of the intestine, when the destructive process has involved or nearly reached the serous membrane. Later perforations are usually due to deep serpiginous ulcers. The immediate causes of perforation, when the intestinal walls are already thinned by the processes mentioned above, are, the pressure of hardened fæcal masses, over-distention from the accumulation of gas, and, per-

[1] Archiv der Heilkunde. 1872. Heft 6.

haps, the presence of ascarides. (At all events, it is remarkable how often one or more round worms are found free in the cavity of the abdomen on post-mortem examination.) Other immediate causes of perforation may be, straining at stool, violent vomiting, sudden changes of posture, etc. The intestine may also be perforated as the result of diphtheritic processes or gangrene of its walls. The opening is found most frequently in the lower portion of the ileum, though it may take place at a point higher up in the small intestine, or in the colon, especially at the vermiform appendix. The perforation usually shows a round opening in the serous membrane, varying in size from a pin-head to a lentil, extending inwards in the shape of a funnel, and corresponding to an ulcerated Peyer's patch—more rarely to a solitary follicle.

Perforation of the intestine occurs by far the most frequently in the gravest cases of the disease. Still, the lighter ones are not free from the danger of this accident, and it does sometimes happen that the perforating ulcer is found to be almost the only one present in the entire alimentary tract. All observers agree that intestinal perforation is far more frequent amongst men than women.

In the cases collected by Hoffmann there were 20 instances of perforation to 250 deaths, 8 per cent. of the deaths following perforation. In the hospital at Basle, during the years 1865 to 1872, there were, amongst more than 2,000 typhoid fever patients, 23 instances of perforation, or, if we include 3 that recovered, 26, or a little more than 1 per cent. of all those having the fever. Of 21 cases, 15 were men and 6 women, while the ratio of men to women in the typhoid fever wards was about 4 to 3. Among 22 cases in which the chronology was reliable (including 18 of those cited by Hoffmann), perforation took place, at the end of the second week, twice; during the second half of the third week, 6 times; in the fourth week, twice; in the fifth week, six times; in the sixth and seventh weeks, each twice, and later than that, twice.

Griesinger had 14 perforations to 118 deaths (nearly 12 per cent.), among 600 patients ($2\frac{3}{10}$ per cent.). Of the 14 cases, 10 were men and 4 women, while the ratio of men to women amongst the patients was about 4 to 3. Murchison has seen 24 cases, 16 men and 8 women; while in the general mortality from typhoid fever the proportion of women slightly exceeded that of men. Eleven out of fifteen cases seen by Bristowe were in men. From a collection of cases by Näcke,[1] it appears that of 106 perforations, 72 were in men and 34 in women. According to

[1] Ueber Darmperforation im Typhus abdominalis. Dissertation. Würzburg. 1873.

the same author, 84 out of 185 cases occurred during the first three weeks, and 99 later; 62 out of 117 cases during the first four weeks, and 55 later. Of 136 cases (from which we omit some that are counted twice), 106 perforated the ileum, 12 the colon, and 15 the vermiform appendix. Hoffmann, one of whose 20 cases perforated the colon and two the vermiform appendix, gives the following as the site of 18 perforations of the small intestine (one case, being double, is counted twice). Once the perforation took place immediately above the ileo-cœcal valve; four times at four to six inches above; nine times at eight to twenty inches; twice at four and a half to six feet above; once at ten feet above; and in one case there were 25 to 30 perforations in the jejunum.

The immediate result of perforation is *acute peritonitis*, which is always diffuse, unless the opening in the bowel is immediately closed again, and runs its course with the usual symptoms of the severest peritonitis. In some cases, large quantities of gas escape from the bowels and produce pneumatosis of the abdomen; the epigastrium protrudes, the liver sinks from its normal position in the hollow of the diaphragm, and its place being occupied by gas, the usual dulness on percussion over what is known as the region of the liver disappears. The patient often experiences, at the moment of perforation, a sudden and very severe pain, causing him very nearly to faint; it usually begins in the right inguinal region and extends thence over the rest of the abdomen. A state of collapse often supervenes, probably as the result of shock, with cold extremities, sometimes cold sweat, a small, weak pulse, and frequently a fall of temperature in the interior of the body. This fall of temperature, too, sometimes causes the disappearance of previous severe brain symptoms. In the case of one patient under my observation, who had lain for some time in a deep stupor, consciousness was completely restored after a reduction of temperature of 5½ degrees during the day (from 104° to 98.5° Fahr.), following perforation. In other patients the evidences of mischief are developed less suddenly, and if a speedy closure of the opening prevents the escape of any considerable amount of the intestinal contents, the symptoms of peritonitis may even develop themselves quite tardily. In some very sick patients the perforation and subsequent peritonitis may run their course undiscovered; but usually the severe pain is enough to arouse one even from a deep

stupor. Occasionally, in the most sudden and severe cases, the patient dies during the collapse, within a few hours of the time of perforation, and then the peritoneum is only found strongly congested, not inflamed. The vast majority of cases, however, survive the shock, and then the temperature begins to rise again, often accompanied by chilly sensations or even heavy chills. Most commonly the attack proves fatal within four days (this was true in 13 out of 16 of my cases); exceptional instances, however, occur of persons who survive for weeks, or even recover.

As regards the *diagnosis* of intestinal perforation, this is made probable when we find evidences of peritonitis present, the more so when they have supervened suddenly. It must, at the same time, be remembered that severe and even fatal peritonitis may arise without perforation of the bowel. The diagnosis of perforation is unequivocal when one can demonstrate the presence of gas free in the abdominal cavity, especially when the normal dulness over the region of the liver, after having been shown to be present, suddenly and more or less completely disappears. It must not be forgotten, however, that loops of intestine may lie over the liver. In pneumatosis of the abdominal cavity one sometimes gets a peculiar quality of sound, especially on rather deep percussion, which reminds one somewhat of the "cracked-pot sound." In some cases we can do no more than suspect that the peritonitis present is caused by a perforation; while in other cases the existence of a perforation is revealed by a post-mortem examination, when it had never been suspected during life.

In one case of this accident, after typhoid, which occurred in Botkin's clinic, Tschudnowsky[1] discovered an exquisite amphoric murmur, which was synchronous with the respiration, and could be heard on auscultation of the abdomen over the point at which there was an accumulation of free gas. He attributed the sound to the exit and entrance of air through the opening in the intestine.

Whenever the presence of a perforation can be positively established, our *prognosis* is most unfavorable. Still, in rare instances, recovery takes place. The possibility of recovery is

[1] Berliner klinischer Wochenschrift. 1869. Nr. 20, 21.

proved by those cases in which, the healing process having pro gressed up to a certain point, the patient is carried off by some intercurrent complication or accident, and we are able to demonstrate the condition of things on the dead body. Aside from this, however, there are a few rare cases on record of undoubted perforation of the bowels ending in complete recovery. I have myself seen four such. Three of them took place during the year 1870, two in hospital, the other in private practice. In all three, the attack was very sudden ; there was well-marked pneumatosis of the abdomen, and complete loss of liver dulness in front. Under the persistent use of opium complete recovery followed, and the normal percussion sound over the liver gradually returned. In the case of an opening that is shut off from communication with the abdominal cavity, and from which but little gas has escaped, the chances of recovery are better ; but our diagnosis here is uncertain, and may perhaps be said never to be positive unless subsequently an opening establishes itself on the surface of the body and affords escape to intestinal contents.

Nothing conclusive has yet been established with regard *to the influence of the cold-water treatment* on the frequency of this complication. In the hospital at Basle there were 12 cases of perforation to 973 typhoid-fever patients *before* the introduction of the cold-water treatment, and 14 to 1,108 *after* the same, or, counting only the fatal cases, 11 to 1,108. The difference is too little, and the entire number under observation too small to be of conclusive evidence in the case.

Peritonitis without perforation may arise from various causes. It is most frequently due to the fact that the typhoid infiltration, so frequent in various tissues of the body, takes place also in the serous membrane ; or, that ulcers penetrate to this membrane ; in which case an originally circumscribed peritonitis may gradually become diffuse. In other cases it is due to partial necrosis of the mesenteric glands ; to infarction within the spleen ; to abscess of the ovary, or to other complications. In two patients, whom I saw, it was the result of rupture of the gall-bladder, with the escape of gall-stones into the cavity of the abdomen. Severe general peritonitis, without perforation, has occurred in

Basle 16 times among about 2,000 typhoid patients, with 15 deaths. In striking contrast to the rule that applies in cases of peritonitis due to perforation, we find this variety of peritonitis most frequent among women; in 16 cases 6 were men and 10 women. Instances of circumscribed, or even of diffuse peritonitis, of moderate intensity, are frequent, and often end in recovery.

Serpiginous ulcers appear, at times, to run their course and become healed without giving rise to any special symptoms; occasionally, however, they cause perforation at a late date, after apparently complete recovery. In other instances a slight, but prolonged, febrile condition is maintained; and I have once seen this, in connection with profound disturbances of digestion, lead to extreme marasmus and death.

Diphtheria of the intestinal mucous membrane is an occasional sequel to severe cases of typhoid fever, as it is also to severe forms of other diseases; especially when other mucous membranes of the body, as those of the pharynx, larynx, trachea, gall-bladder, or urinary organs, are at the same time the seat of diphtheritic inflammation. I have repeatedly found this condition of things in the large intestine, in one instance also in the jejunum, where it had given rise to numerous perforations. We are not to regard such cases as presenting evidence of any specific inflammation, but merely as instances of the death of the superficial layer of the mucous membrane, due, perhaps, partly to degeneration, and partly to the general lowering of nutrition and the circulation.

We may account in the same way for *gangrene of the intestinal mucous membrane*, which occurs sometimes after diphtheritis, sometimes without it; and, in the latter case, is most commonly found in the vicinity of ulcers. Deep gangrene is, of course, liable to produce perforation.

Hoffmann found 9 cases of well-marked gangrene of the intestinal wall among 250 subjects of post-mortem examination.

It occurred six times in the ileum, twice in the vermiform appendix, and once in the sigmoid flexure. These cases are included among the statistics of perforations given before.

In addition to the changes ordinarily produced by typhoid fever, the *spleen* is especially liable to be the seat of *hemorrhagic infarctions*. Some of these are unquestionably due to emboli, having their origin in heart-clots. Post-mortem examination, every once in a while, shows us, in addition to hemorrhagic infarction of the spleen, old clots in the left side of the heart and infarctions in other organs of the body. It is not yet positively determined whether infarctions may be produced by simple coagulation of blood in the vessels of the spleen, due to diminished circulation. Some of the smaller infarctions run their course without any prominent symptoms, and heal with the formation of a cicatrix; others create considerable disturbance, or lead to serious results. This accident may be counted as amongst the prominent causes of peritonitis without perforation. In other cases, especially where the infarction is extensive, softening is liable to occur, producing an abscess filled with puriform detritus, which may involve the greater part of the organ, and which may either perforate in various directions, or may produce peritonitis and death without perforation.

Hoffmann found nine cases of infarction of the spleen in 250 post-mortems, that is, in $3\frac{6}{10}$ per cent. of the deaths. Among these there were seven that had died before the end of the fourth week. Griesinger, basing his estimate on an accumulation of cases from reliable observers, calculates that this complication is found in 7 per cent. of the fatal cases. He also declares it to be of most frequent occurrence in the later periods of the disease.

The following conditions were observed in a woman who was under my observation, and in whom, during life, it was easy to demonstrate the gradual development of very serious dilatation of the heart, the result, doubtless, of the degenerative processes incident to the fever. After death, large, pale, firmly adherent clots were found in both sides of the heart; the interior of some of these clots having undergone purulent degeneration. The spleen, which was three times its natural size, was transformed into an abscess, occupying seven-eighths of its volume, filled with purulent, watery detritus and shreds of necrosed tissue. Death was occasioned by general peritonitis, with no opening of the abscess.

Rupture of the spleen may be noticed as an accident of very rare occurrence.

In a patient who leaped from a window, while delirious, and died twenty-four hours later, having received other injuries, there was found a rupture of the investing capsule of the spleen at three different points, with slight escape of blood.

Parenchymatous degeneration of the liver, which is found in every severe, prolonged, and fatal case of typhoid fever, has already been referred to when speaking of the conditions regularly following this disease. There are cases, however, in which this degeneration reaches so high a grade as to present a distinct complication, presenting the group of symptoms characteristic of *icterus gravis*, or acute yellow atrophy of the liver. Cases of this kind, following typhoid fever, have been described by Andral, Rühle, Frerichs, and Griesinger. We must also make allusion to those instances in which parenchymatous degeneration manifests itself by the development, during the course of the fever, of a fatty liver of the most aggravated form, in which the cells are filled with large drops of fat. I have already described one such case[1] in which this form of degeneration was found in a young girl who died during the fourth week of a severe attack of typhoid fever. I have since met with several such cases, in none of which, however, have the changes been as characteristic as in this one.

Abscesses of the liver are rarely met with as sequelæ to this disease.

Not quite so rare are *diphtheritic processes and ulcers*, on the mucous membrane of the *gall-bladder*. In one case that occurred at Basle, the entire mucous membrane of the gall-bladder was found detached and floating about as a ragged membrane, only a narrow band still connecting it with the fundus of the bladder, which was largely distended. In another case the detachment of the mucous membrane was less extensive, and confined to the neighborhood of an ulcer. In both cases gall-stones were found in the bladder. Two instances of perforation of the gall-bladder, with the escape of calculi, were mentioned under the head of peritonitis. In all of these, undoubtedly, the presence of the gall-stones was the immediate

[1] Beiträge zur patholog. Anatomie und Klinik der Leberkrankheiten. Tübingen 1864. S. 353.

cause of the ulceration; but the fact of its occurring during the course of a typhoid fever, would indicate that the tissues of the gall-bladder participated in the general tendency to disintegration.

Icterus occurs less frequently during typhoid fever than in many other febrile affections, as, for instance, pneumonia. The general disposition is to regard such an icterus as merely catarrhal, dependent on an extension of the catarrh from the bowels to the biliary passages. This solution of the question, which is unmistakably correct in some cases, is doubtful in others, because the evacuations from the bowels never lose their biliary color. It is very common, in post-mortems after typhoid fever, to find the bile quite fluid, and often strikingly light-colored; in those cases, especially, in which jaundice has occurred, there is frequently evidence that the secretion of bile was diminished, but not that there was any obstruction to its flow. If we, furthermore, remember that in cases complicated with jaundice there is usually an especially marked degeneration of the liver (a fact which Hoffmann also insists on), we shall be the more inclined to attribute the jaundice to this degeneration of liver-cells, and the consequent interference with the functions of the organ. It would then fall within the same category as icterus accompanying acute yellow atrophy. It appears, thus, that under some circumstances the occurrence of jaundice may affect the prognosis very unfavorably, inasmuch as it suggests the fear of advanced hepatic degeneration. This is all the more so if the jaundice supervenes at the height of the disease, or soon thereafter in a severe case; if it is unaccompanied by a lack of color in the fæces, or other evidences of obstruction of the biliary passages; and especially if albuminuria is present, pointing to advanced parenchymatous degeneration of the kidneys. At the same time, I must admit that I have seen jaundice occur in light or abortive cases of the fever.

In the hospital at Basle icterus was observed twenty-six times in 1,420 cases of the disease; 14 of these were men and 12 women. Hoffmann found ten cases of strongly marked icterus among 250 post-mortems. Griesinger reports ten attacks of jaundice among 600 typhoid-fever patients.

The ordinary changes that take place in *the mouth*, during

the course of the fever, have already been noticed. As special complications, we may meet with higher grades of *catarrh of the buccal mucous membrane*, often followed by *ulceration*. The latter is often found at the edges of the tongue, as well as at the point of union of the mucous membrane of the mouth with that of the gums. These ulcerations frequently lead to gangrene, which is usually superficial, but sometimes deep. In one fatal case, such an ulcer resulted in extensive gangrene around the left half of the lower maxillary bone of such a character as to remind one of noma.

Parulis or alveolar abscess is liable to occur at any stage. In one of the patients at the Basle hospital, who recovered, an alveolar abscess led to extensive suppuration, with emphysema of the skin on the affected side.

Catarrh of the *fauces* and the *pharynx* is of very frequent occurrence. Many patients, especially at the beginning of the disease, suffer from catarrhal sore throat, with its accompanying discomforts. Catarrh, occurring at any of the points above named, readily leads to superficial ulcerations. Diphtheritic processes on the mucous membrane of the fauces, which may spread to the œsophagus, or to the larynx and trachea, lead to deeper ulceration, especially in the lower portions of the pharynx.

All these processes, occurring in the pharynx, may extend to the *Eustachian tube* and *middle ear*. Serious deafness may be produced in this way, and yet, as has already been stated elsewhere, we are not justified in attributing to these causes all the disturbances of hearing that are met with in typhoid fever patients. The affection of the middle ear may lead to perforation of the membrana tympani, or to caries of the petrous portion of the temporal bone.

Hoffmann found fourteen cases of deep-seated disturbance of the facial mucous membrane. He met with perforation of the membrana tympani four times, twice accompanied by caries of the mastoid process, and in one of the latter the perforation, as well as the caries, occurred on both sides. Besides this, perforation of the membrane occurred in a number of patients in the hospital at Basle, who eventually recovered.

The formation of *aphthæ* is rare, and usually occurs only in

those patients who are lying very low, and in whom death, from general prostration, is imminent. In the case of ill-ventilated or over-crowded hospitals, however, this rule may be reversed.

Such an over-crowding took place at the Basle hospital (which was then considerably smaller than now), during the extensive epidemic of 1865, at which time even a part of the corridors were filled with patients. During four months, eight cases of the development of aphthæ during life were observed, and were confirmed by microscopic examination. Three of these recovered. I would remark, here, that eight cases of gangrene of the lung following typhoid fever, occurred at the same time. Hoffmann found strong aphthous growths in eighteen bodies, at the time of the autopsy; these cases occurred chiefly in groups corresponding to the times when the hospital was the most crowded. In some instances the aphthæ extended into the pharynx and œsophagus, and in one case the lower part of the œsophagus was almost completely filled with them.

Swelling of the parotid gland, which terminates in resolution, may sometimes be due to an extension of the catarrhal process from the mouth through the duct of Steno. *Suppurative parotitis* used to be considered as a result of metastasis. According to Hoffmann, it consists merely in an exaggeration of the changes that usually take place in this gland during typhoid fever, and bears the same relation to those changes that ulceration and perforation of the intestine do to infiltration of the intestinal follicles. Whereas the swelling of other glands, which is found in all severe cases of typhoid fever, even though it be accompanied with cell degeneration, commonly recedes without creating much disturbance, parotitis leads to more serious changes. Numerous points of suppuration and breaking down of tissue appear, involving both the glandular and the intermediate cellular structure; these isolated collections soon become confluent; and, in the worst cases, large portions of the gland are thus transformed into cavities, containing pus and torn fragments of altered tissue. The fact that this suppurative process is usually confined to the parotid, that it rarely invades the other salivary glands, and hardly ever the pancreas (though all of these are equally subject to the ordinary parenchymatous changes characteristic of the fever), is attributed by Hoffmann to the close and tough texture of the fascia enclosing the parotid, whereby swelling of the confined gland producing extreme pres-

sure more readily leads to severer inflammation. This destructive inflammation may also extend to neighboring parts; fistulous tracts may extend down the neck, or we may have thrombosis of the veins, periostitis, suppuration of the masseter or pterygoidei muscles, or, finally, diffuse purulent infection and septicæmia. The pus formed in these abscesses may find its way to the surface, or may open into the external auditory canal. The facial nerve, or some one of its branches, is sometimes involved in the destructive process, or it may be severed by incisions made to evacuate pus, in either case leaving paralysis of the muscles to which it is distributed.

According to Hoffmann, 16 cases of suppurative parotitis were found at Basle among about 1,600 typhoid-fever patients, 7 of the 16 proving fatal. Parotitis without suppuration occurred 3 times. In 15 cases the attack was confined to one side, 9 times to the right and 6 to the left; in 4 it was double.

Parotitis begins most frequently during the third or fourth week, sometimes without producing any very marked symptoms, at first, in a patient who is lying very low. It is almost always confined to the most severe cases, and is a bad prognostic sign; first, because it gives evidence of the probably advanced degeneration of other organs; and secondly, because in itself it begets new fever and aids in exhausting the vital powers; furthermore, it may threaten life by the spread of its destructive processes to neighboring parts, or by its other unfavorable consequences.

Since the introduction of a systematic *antipyretic treatment* the frequency of suppurative parotitis has greatly diminished. Whereas, previously, one case occurred to every hundred typhoid-fever patients, since the year 1872 (inclusive) but two cases have occurred among 1,100 such patients. Both these cases terminated fatally. This experience is well calculated to support our view that the changes commonly occurring in the salivary glands during typhoid fever, and whose excessive development produces suppurative parotitis, belong to the class of parenchymatous degenerations that are brought about by an elevated temperature of the body.

The *œsophagus* is frequently the seat of catarrh, and occasionally of aphthæ and diphtheria.

One case is on record of softening of the œsophagus during life, in which the appearances were similar to those in that rare ante-mortem condition called melanotic softening of the stomach. (Compare Hoffmann, l. c. p. 171.)

II. *Organs of Circulation.*

The condition of the circulatory apparatus, and especially of the heart, constitutes a feature of grave import in the complications and sequelæ of typhoid fever, as it does also in the symptomatology and prognosis of the simpler cases. Especially do the results of *degeneration of the muscular tissue of the heart* lead to manifold complications; and this degeneration, to a greater or less degree, exists in all severe cases of the disease, without exception. Amongst other things, the diminution in the propulsive power of the heart causes or favors hypostatic congestion, as will be shown hereafter, as well as various inflammatory processes. This cardiac weakness, as before stated, is also in part responsible for the tendency to disintegration which is found in all tissues of the body. On the one hand, the nutrition of various parts is interfered with, by reason of the small amount of blood furnished to them; on the other hand, the diminished arterial tension in the smaller vessels renders it possible for quite moderate swelling of the tissues still further to embarrass, or completely to arrest, the stream of the circulation. Cardiac weakness, then, may be held responsible for part of the causation in all necrotic or gangrenous processes, as, for instance, in some forms of diphtheria of mucous membranes, in bed-sores, etc.

It may, perhaps, seem strange that while general dropsy, beginning in the lower extremities, is one of the most constant symptoms of chronic degeneration of the heart, it very rarely occurs, to such an extent, at least, as to attract attention, during the height of the disease in typhoid fever. This may, possibly, be in part because the evaporation of water through the skin is increased above the normal standard during the height of the fever; it is also probable that œdema of the lower extremities would be more frequent if the patients were occupying an upright instead of a recumbent posture. But the main ground

for this difference undoubtedly is, that typhoid-fever subjects, with well-marked heart degeneration, usually die too soon, from paralysis of that organ, to permit of the development of general dropsy ; whereas, in those cases that recover, the fall of temperature is soon followed by the return of at least an approximately normal action of the heart. For that matter, though, I have met with not a few cases in which a high degree of cardiac weakness had persisted for quite a while, and in which, even at the height of the fever, a slight, or even a considerable œdema of the legs (without thrombosis) appeared. And finally, in cases where considerable weakness of the heart's action is experienced during a long period of convalescence, decided dropsical appearances, together with all the other results of interruption to the general circulation, are common.

Occasionally a case appears in which, at the climax of the disease, and when the heart-weakness has reached a high grade, percussion betrays an extension of cardiac dulness towards the right side ; some post-mortems, too, have revealed, in addition to advanced degeneration of the muscular tissue, a notable dilatation of the right ventricle, more rarely, also of the left, no cause for this enlargement, other than the degeneration, being apparent. In one instance dilatation of the heart, which had been diagnosticated during life, was found still to persist in the second month of convalescence, when the patient died of peritonitis. In the majority of favorable cases, however, the extended area of dulness over the heart soon recedes.

Excessive cardiac weakness, especially when combined with dilatation, often results in *blood-clots in the heart.* Some of these may be recognized as having been formed during life, by their being so closely interwoven with the muscular trabeculæ or chordæ tendineæ ; others give evidence, by their firm adherence, their color, and especially by the purulent degeneration that has taken place within them, of having existed long before death. By the breaking loose of portions of such thrombi in the right side of the heart, embolism of the pulmonary artery results ; while the same accident in the left heart produces embolism somewhere in the course of the general circulation, most frequently in the spleen or kidneys.

Ordinary venous thrombosis, most frequently met with in the course of the crural vein, also depends on weakness of the heart's action.

In the hospital at Basle 31 cases of thrombi in the veins of the lower extremities occurred among 1,743 typhoid-fever patients, the majority being amongst men.

In most of them, thrombosis did not occur until during the period of convalescence, in some few, however, as early as the third or fourth week. In 24 cases, 16 of which were in men and 8 in women, the thrombosis occurred 18 times in the crural vein, 5 times in the saphena, and once in the popliteal. Thrombosis of the crural vein took place twice on both sides simultaneously, 4 times on the right side, and 12 times on the left.

The saphenous vein was affected once on the right side and 4 times on the left: the thrombus in the popliteal was on the left side. Thus we have this accident occurring 5 times on the right side to 17 times on the left; a circumstance which may doubtless be explained by the fact that the left common iliac vein, being crossed by the right common iliac artery, does not admit of as ready a flow of blood as the vessel of the other side.

Venous thrombosis in typhoid fever presents the same features and runs the same course as non-septic thrombosis in other diseases. It usually terminates in recovery, and has but little prognostic significance. Only two cases, out of thirty-one, proved fatal, a favorable result which must undoubtedly be due to the fact of the complication occurring so late in the disease. In rare instances, thrombosis of the veins may cause death, a portion of the thrombus becoming detached and producing embolism of the pulmonary artery.

It was in this way that death was produced in the only fatal case that has occurred since I have been in charge of the clinic at Tübingen, during which time we have treated but 24 cases of typhoid fever. The patient was admitted during the third week of the disease. At this time there was very weak heart's action, and a pulse that ran from 136 to 150. We had succeeded in modifying the high fever, and in overcoming the danger of cardiac paralysis, when embolism of that branch of the pulmonary artery that goes to the lower lobe of the right lung took place. The embolus arose from a thrombosis of the right crural vein. It was accompanied with extensive hemorrhagic infarction, and resulted in death.

Endocarditis and *pericarditis* are comparatively rare complications or sequelæ of typhoid fever.

In the case of one hospital patient, at Basle, who had been through a mild attack of the fever, there arose, during convalescence, an endocarditis of the aortic valves,

with extensive warty growths, and perforation of two of the semilunar folds. The results were, hemorrhagic infarctions in the kidneys and spleen, and double pleuro-pneumonia, of which the patient died.

A milder form of endocarditis, without ulceration, is of more frequent occurrence.

During one year four cases of pericarditis, after typhoid fever, fell under my observation, all of which recovered. Usually, however, they are more rare. Once in a while, on post-mortem examination, a slight degree of pericarditis may be found, which is, so to speak, accidental, and no part of the typhoid complication.

III. *Respiratory Apparatus.*

It has already been stated that genuine, simple *catarrh of the nasal mucous membrane* is one of the rarest occurrences, both in the prodromic stage of typhoid fever, and during the course of the disease, so that the presence of an ordinary, recent "cold in the head" may be considered as diagnostic evidence against the existence of this malady. In point of fact, the mucous membrane of the nose early shows a tendency to undue dryness; the secretion, if there be any, is thick, tough, and clotted, often slightly tinged with blood. Catarrhal and ulcerative processes, more particularly those that are diphtheritic in nature, may, however, spread from the fauces and posterior nares to portions of the mucous membrane of the nose.

Epistaxis is of frequent occurrence, taking place, most generally, within the first week of the disease.

During the years 1865 to 1868, inclusive, the records of the Basle hospital show 107 cases of nose-bleed, among 1,420 typhoid-fever patients ($7\frac{5}{10}$ per cent.). Twenty-one of the 107 died, although in only two of these could the profuse bleeding be considered as the proximate cause of death. In one of them the coexistence of lock-jaw prevented the effective application of a tampon; after death, blood was found in many of the alveoli of the lungs.

The posterior nares had to be plugged in 29 of the cases; in 14 there was also hemorrhage from the bowels, and in 4 petechiæ appeared on the skin. In 1 case the nose-bleed was merely one amongst numerous evidences of a hemorrhagic diathesis. In about half the cases the bleeding occurred within the first week. It is most frequent amongst the young, no instance thereof occurring in patients over 40 years of age.

Under some circumstances *diffuse diphtheritic* and *croupous processes* may extend into the larynx, and there produce deeper

ulcerations and disturbances. The mucous membrane of the trachea, however, is rarely thus invaded.

Those laryngeal ulcers which are common in typhoid fever, and which have been called *typhoid ulcers*, were formerly considered as analogous to the intestinal ulcers, and were thought to depend on a specific typhoid infiltration of the laryngeal glands. These are at present regarded as secondary changes, resulting from a circumscribed "diphtheritic" infiltration of the mucous membrane. Laryngeal ulcers are of comparatively frequent occurrence. They are usually small, but may extend both in breadth and depth; frequently a number exist at the same time, and they may become confluent. They are most commonly found on the posterior wall of the larynx, and hence readily involve the posterior insertion of the vocal chords. They may also be located on the epiglottis, especially on its lateral edges, and there produce considerable disturbance. Ulcers of the larynx may sometimes run their course without producing any notable symptoms. At other times, when the vocal chords are attacked, or even when the swelling which arises about an ulcer extends to the chords, the voice becomes rough and hoarse, or may even entirely lose its resonance; sometimes a severe cough is induced, or there may be the greatest difficulty in swallowing. As a general rule, laryngeal ulcers do not in any way affect the ordinary course of the disease, and, in favorable cases, heal without leaving any evil consequences. Occasionally, however, they may lead to death, usually by producing perichondritis laryngea or œdema of the glottis.

In 250 post-mortems Hoffmann found laryngeal ulcers present 28 times; in 22 of these the ulcer had penetrated to and involved the cartilage. Four of the 28 had died during the second week, 9 during the third, 5 during the fourth, and 10 from the fifth to the eighth weeks.

Griesinger, after a comparison of many different reports, estimates that typhoid ulcers of the larynx occur in about one-fifth of the fatal cases. In his own experience, they were present in 26 per cent. of the cases that died, being somewhat more common with men than women. In one-third of the cases, they were found during the period of infiltration and necrosis of the intestinal mucous membrane; in two-thirds during the period of ulceration or of commencing cicatrization.

Catarrh of the smaller bronchi is of such frequent occur

rence in typhoid fever that one is justified in attaching thereto a certain diagnostic significance. It usually develops itself about the end of the first week, and is most pronounced in the inferior posterior portion of the lung. In many cases it does not announce itself by a cough, nor by any subjective symptoms, and is only discovered by auscultation; at other times it is accompanied by a cough, with tough muco-purulent sputa.

Catarrh of the smaller bronchi often leads to disease of the parenchyma of the lungs, especially to *collapse* of individual portions of the organ, or to *lobular pneumonia*. The lobular consolidations are sometimes only single, or occur in but small number; at other times they are quite numerous, and may be crowded together in such manner as to produce distinct dulness on percussion, or even sonorous râles and bronchial breathing.

Lobular pneumonia was found by Hoffmann to exist 38 times in 250 post-mortems. Two of these subjects had died in the second week, 8 in the third, 7 in the fourth, 6 in the fifth, and 14 at a later period.

Some changes that take place in the lungs are essentially dependent on weakness of the heart's action. Amongst these may be reckoned, especially, hypostatic congestion and œdema. When the force of the heart's action falls below the normal standard, the arteries are less filled and the veins more filled than before, and this holds equally true of the pulmonary as of the general circulation. Another prerequisite, however, to the production of hypostatic congestion is, that the force of gravity should exercise a material influence on the distribution of the blood, and this can only come to pass when the heart's action and the arterial tension are reduced to a very low ebb. Then blood accumulates at the most dependent portion of the lung, and hypostatic hyperæmia results; the tissue of the lung is often, at the same time, infiltrated and swelled, the capacity of the alveoli is diminished by the overfilling of the vessels and the swelling of tissue, and the last remnant of air is often driven out by the effusion of free fluid; thus, part of the dependent portion of the lung becomes entirely void of air, and the condition known as *splenization of the lung* ensues. If an inflammatory process now supervenes, leading to a sort of flabby

hepatization, we have true hypostatic pneumonia. This term is often used loosely, and is applied to that condition which we designate as splenization, in the production of which no true inflammatory process has taken part. Hypostatic congestion begins to develop itself as soon as the force of the heart is notably reduced, which occurs usually during the third week, but often as early as the second. The more quietly the patient has lain upon his back, and the more the alveoli have already collapsed, as the result of feeble inspiratory effort and imperfect expansion of the lungs, the earlier and the more readily will certain regions become entirely devoid of air. The graver forms of hypostatic trouble, interfering with the respiratory function over considerable areas, are readily recognized by percussion. Dulness over the lower posterior part of the lungs is most likely to be due to this condition, when it exists on both sides simultaneously, when it is accompanied by well-marked weakness of the heart, and when it has developed itself gradually and without any fresh exacerbation of fever.

Hypostatic congestion of the lungs aggravates the condition of the patient, inasmuch as it interferes with the function of respiration; but its most important prognostic significance lies in the evidence it furnishes of a high degree of cardiac weakness.

One hundred out of 1,420 typhoid-fever patients in the hospital at Basle, gave evidence of the complication we are now considering: 50 of the 100 died. In 45 of these the chronology was carefully kept, and showed evidences of the hypostatic condition to have appeared during the first week in 9 cases, during the second week in 10, during the third in 17, during the fourth in 4, and later than the fourth week in 5 cases. In 35 cases in which Hoffmann found splenization of the lung present, death had occurred in 6 during the second week of the disease, in 12 during the third, in 9 during the fourth, in 6 during the fifth, and in 2 at a later period.

More or less extensive *œdema of the lungs*, often spreading over a considerable portion of the organs, but most strongly marked in the more dependent parts, is of common occurrence in combination with other diseased conditions of the lung; aside from this, however, it is always to be found in cases where the heart's action has been reduced to a very low ebb, for a con-

siderable period, and has, at last, been gradually extinguished. Œdema is often produced during the death-struggle, and must then be regarded as a mere accident of no importance. Often, however, it is of the greatest consequence, inasmuch as it constitutes the only immediate cause of death. In fact, the way that paralysis of the heart kills (when its approach is gradual) is commonly by producing œdema of the lungs, and thereby suffocation. In accordance with this rule, Hoffmann found marked degeneration of the muscle of the heart in all those cases in which pulmonary œdema was the only demonstrable cause of death.

The greater part of the *hemorrhagic infarctions* that occur in the lungs are indirectly dependent on feebleness of the heart. Most commonly they depend on embolism of some branches of the pulmonary artery, due to clots that have formed in the right side of the heart and broken loose; more rarely they take their origin from a thrombus of the crural vein. The embolus may also arise from a peripheral accumulation of inflammatory or ichorous matter, as from an extensive bed-sore, from an inflamed parotid gland (though this is rare), from an ichorous abscess within muscular tissue, from a peritoneal collection, etc. It is very doubtful, in my mind, whether the primary intestinal lesion of typhoid fever, even though the loss of tissue be considerable, can ever lead to the formation of emboli and to infarction of the lungs. I have never seen a case where embolism was even suspected of having originated in this way.

Sometimes but one area, or but few areas, of infarction are found in the lungs, and then they may be large; at other times they are numerous and small. Occasionally it is impossible to diagnosticate them during life, even when they are extensive enough, or lie near enough together, to produce well-marked dulness on percussion. In the absence of other distinguishing marks, one cannot say positively what the nature of the consolidation is. In other cases the sudden rise of pleuritic pains, the appearance of dark blood in the sputa, and the abrupt rise of fever, without other apparent cause, may point towards the diagnosis; especially when such weakness of the heart's action

is present as to make the formation of clots probable, or other morbid conditions exist which might easily produce emboli.

The changes which are likely to take place in hemorrhagic infarctions depend, in part, on the nature of the embolus by which they are caused. If the latter originates in a collection of purulent or ichorous matter, the former is very likely to undergo purulent degeneration or to result in circumscribed gangrene of the lung, frequently surrounded by a pneumonic zone, or accompanied by pleurisy. If, on the other hand, the infarction results from a simple heart-clot, or from a simple thrombus, of peripheral origin, it may terminate in absorption and cicatrization. But even this latter class of infarctions may eventually lead to extensive pneumonic infiltration in their vicinity, and to pleurisy; finally, they may even become gangrenous, in which case we may suppose that the septic elements, which were not contained in the embolus, were introduced with the air in inspiration. Hemorrhagic infarction, which can be recognized during life, makes the prognosis decidedly more unfavorable.

In 250 post-mortems Hoffmann found 15 cases of hemorrhagic infarction of the lungs.

Lobular pneumonia constitutes a frequent and serious complication or sequel of typhoid fever. It occasionally appears under the form of ordinary croupous pneumonia, and presents all the characteristics of the same on anatomical examination. In the majority of cases, however, the infiltration is less massive and less firm, even when the tissue is entirely devoid of air, and the œdematous swelling of the lung tissue appears evidently to have borne an important part in so completely expelling the air. All grades of consolidation may be found, from firm, tough hepatization to what is called flabby hepatization, in which, on a transverse section, the granulations are found to be smaller, less firm, and less prominent. This complication supervenes most frequently at the height of the disease, that is, during the second or third week. It may, however, occur later, and especially during the period of convalescence. Finally, there are cases where it appears very early,—during the first

week,—so that the patient comes under treatment presenting a well-developed pneumonia. When pneumonia does not supervene until convalescence is well advanced, it is most likely to follow the course of ordinary croupous pneumonia, and this is the more likely to be the case the further the patient has advanced towards recovery. Still, even then, as we often see in persons debilitated from any cause, the disease may lack some of its usually characteristic features, as, for instance, the rusty sputa. Those cases in which the pneumonic symptoms are developed at the height of the disease, or during early convalescence, usually have the type of secondary pneumonia, which often shows itself only through an increase of fever, sometimes with rigors, and through the physical evidences of infiltration. The cough is often not perceptibly increased, the characteristic sputa are lacking, and pain is often entirely absent, or very insignificant. The same thing is true when this condition is developed very early in the disease, as during the first week. It will often be impossible to determine, on the first examination, whether one has a case of idiopathic, asthenic pneumonia before him, or one of typhoid fever with secondary pneumonia. These cases of typhoid fever, with early and extensive inflammation of the lungs, constitute a part of what has been designated as "typhoid pneumonia" (pneumo-typhus), though this name has been more frequently given to idiopathic, asthenic pneumonia, with typhoid symptoms; a state of things having nothing at all to do with typhoid fever, and easily to be distinguished from it on careful examination.

During the period extending from 1865 to 1868, 1,420 cases of typhoid fever were treated at the Basle hospital, and among these were found 52 cases of extensive consolidation of the lung, not dependent on hypostatic congestion. Twenty-nine of these, or more than one half, terminated fatally, and in the majority of them pneumonia was the immediate cause of death. It must be remembered, however, that amongst the extensive consolidations spoken of above, there were a good many in which this was produced by the presence of numerous, closely aggregated lobular infiltrations. Among 250 cases of death from the fever, Hoffmann found only 18 with actual lobar (croupous) pneumonia. Amongst those of the 1,420 who recovered, less extensive infiltrations not referable to hypostatic congestion, were demonstrated to be present in 27 cases; a good many of these, no doubt, being the subjects of true lobular pneumonia.

Gangrene of the lung follows hemorrhagic infarction, especially when the embolus, which produces the latter, has originated from an inflammatory or ichorous source. This gangrene is very likely to remain circumscribed. It may also originate in structures which are the seat of simple lobular pneumonia. Diffuse pulmonary gangrene occasionally results from the breaking down of a lobar infiltration, without previous consolidation. A high degree of cardiac weakness seems to aggravate the tendency to this condition. Diffuse gangrene commonly manifests itself by the ordinary symptoms, while the circumscribed variety is frequently not recognized during life.

During the six years extending from 1865 to 1870, the Basle hospital showed 14 cases of gangrene of the lung, among about 230 deaths. The importance of septic influences in the production of gangrene, may be inferred from the fact that 8 of the 14 cases observed during a period of six years, took place in the months of September to, November 1865, the very time when the hospital was more overcrowded than ever before or since.

Griesinger reports 7 cases of pulmonary gangrene in 118 post-mortems.

In exceptional instances, the fluids infiltrated into the lung are not absorbed, or only partially so. *Chronic pneumonia* then remains, and sometimes persists, as such, for a long time, and is eventually cured; but at other times it terminates in *pulmonary phthisis*. This happens most frequently with lobular infiltrations, especially at the apices of the lungs; the infiltration into an entire lobe may also persist, either partially or completely, and afterwards become cheesy, and take on rapid degeneration, with the formation of cavities. Pulmonary phthisis is a tolerably frequent sequel of typhoid fever; it is impossible to give exact figures with regard to its frequency, because in most cases patients were discharged from the hospital and lost sight of before it was developed. In individual instances, however, they remained in the hospital until their death, from phthisis; while others, in some of whom the remains of pulmonary infiltration were evident at the time of their being discharged, returned again with well-developed phthisis.

Mettenheimer[1] states that he found 13 cases of pulmonary phthisis, as the sequel

[1] Beobachtungen über die typhoiden Erkrankungen der französischen Kriegsgefangenen in Schwerin. Berlin, 1872.

of typhoid fever, in 38 cases of death, from this disease and its sequelæ, among the French prisoners of war.

Once in a while *general miliary tuberculosis* follows in the train of typhoid fever, either immediately or after some little time, and this without the existence of cheesy or destructive processes in the lungs or in any other organ. Among the 250 post-mortems reported by Hoffmann, this condition was found to exist four times. I have also seen one such case in private practice. Hoffmann considers the miliary tuberculosis to be developed by the accumulation of broken-down cell-masses, which cannot be absorbed, owing to the general depression and interference with the circulation of fluids in the body. While we may admit that these conditions aid in the development of tuberculosis, we cannot suppose them to be responsible for the production of a specific disease such as this. My own presumption is, that the cases under consideration occur in persons who have the specific poison of tubercular phthisis lying latent within them, and that the fever, with its sequelæ, only serves as an exciting cause for the development of these processes. This same theory, of the pre-existence of the specific cause of disease within the body of the patient, might be applied to many cases of ordinary ulcerative phthisis, resulting from chronic pneumonia; while in other cases it is probable that the poison is introduced from without, through the respiration, and finds a congenial soil for its maintenance and development in the infiltrated portions of lung tissue.

Pleurisy, with more or less copious effusion, is a sequel of not very rare occurrence.

It was observed in the hospital at Basle 64 times in 1,743 cases of the fever; 21 of the 64, or nearly one-third, terminated fatally. This great mortality, however, does not correctly represent the influence of the complication on the death rate, for in the reports of post-mortems, every case of pleurisy, however slight, is counted; while amongst those who recovered, there is no doubt that many a case of pleurisy, with little or no effusion, was overlooked. In some instances pleurisy was evidently the cause of death; thus in one woman, in whom the fever had run a mild course, the pleurisy which supervened terminated in empyema, which perforated inward and caused extensive pneumothorax. In most of the fatal cases the pleurisy was dependent on some affection of the lungs (as infarction, gangrene, pneumonia), being independent of these only seven times out of twenty.

As an appendage to the complications affecting the respiratory apparatus, we may here consider disease of the *thyroid gland.*

Acute swelling of the thyroid took place 15 times among over 1,700 patients. In 6 of these, there was suppuration of a part of the gland. Suffocation seemed imminent repeatedly, but all the patients recovered. It may be remarked that a moderate amount of struma is very common amongst the inhabitants of Basle.

It has sometimes been supposed, the supposition being based on *à priori* reasoning, that the use of the cold-water treatment favored the development of pulmonary complications. I myself believe, as the result of experience, that it is possible, in certain rare instances, to encourage the development of some pulmonary attack, as, for instance, pneumonia, by means of a very long-continued and very extreme cooling down of the entire body, including the internal organs. But, on the whole, experience proves precisely the reverse of the above supposition to be true. *Affections of the respiratory apparatus occur rather more rarely, and run their course with less severity, under the cold-water treatment*, than under any treatment which is not antipyretic. This is true even of simple bronchial catarrh, which is less likely to prove serious under the antipyretic treatment,[1] though, on the other hand, it will be observed that the tendency to cough is often increased for a little while immediately after the bath.

Before the introduction of the cold-water treatment, we had 60 cases of lobar and lobular pneumonia, with 30 deaths, among 861 typhoid-fever patients ; since the introduction of cold water, 36 cases and 14 deaths, among 559 typhoid-fever patients. In other words, the frequency of the complication, under the former treatment, was 7 per cent., and the mortality 50 per cent. of that ; under the cold-water treatment the frequency of the complication is $6\frac{4}{10}$ per cent., and the mortality 39 per cent. of that. The frequency of pneumonia, therefore, has diminished but little, though the mortality has been reduced considerably. Consolidations dependent on hypostasis were observed 64 times, with 37 deaths, in 861 typhoid-fever patients, before the use of

[1] Compare the statistics of *Hagenbach :* Aus der medicinischen Klinik zu Basel. Leipzig. 1868. p. 75.

cold water; and 36 times, with 13 deaths, in 559 such patients after its use. The former frequency of hypostatic consolidations, then, was $7\frac{4}{10}$ per cent., 58 per cent. of whom died; while the present frequency is $6\frac{4}{10}$ per cent., of whom only 36 per cent. die, both frequency and rate of mortality being reduced.

If we group together all cases of consolidation of the lungs, whether of hypostatic or pneumonic origin, we can include the statistics of two more years of cold-water treatment. We find, then, before the introduction of the cold-water treatment, 124 cases of consolidation, with 67 deaths, in 861 typhoid-fever patients; after the introduction of this treatment, 96 cases, with 33 deaths, in 882 such patients. The former frequency of pul monary consolidations, then, was $14\frac{4}{10}$ per cent., 54 per cent. of whom died; the recent frequency, $10\frac{9}{10}$ per cent., of whom 34 per cent. have died; both the frequency and the ratio of mortality being materially reduced.

Before cold water was used, 13 cases of hemorrhagic infarction occurred in 861 patients; afterwards 3 cases in 882 patients. Gangrene of the lungs was developed ten times in the former list, and 4 times in the latter. Pleurisy appeared in the former list, of 861, 35 times, with 14 deaths; in the latter list, of 882, treated with baths, 29 times, with 7 deaths, a notable diminution in both frequency and mortality.

IV. *The Nervous System.*

Those disturbances of function of the nerve-centres, which appear as the result of an elevation of temperature, have already been discussed under the head of the symptomatology of uncomplicated typhoid fever. As long as these disturbances are confined within ordinary limits, as to intensity and duration, they cannot be called complications nor sequelæ.

But disturbances of brain function present themselves every little while, which cannot be attributed to the fever, and for which another cause must be sought. It is often no easy matter to determine whether such disturbances are simply febrile or otherwise; the points to be observed being, on the one hand, the nature of the brain symptoms, and, on the other hand, the rela-

tion which these bear to the temperature of the body and its variations, due regard being paid to the characteristics of the individual patient.

We have already noticed the various degrees of *œdema of the brain* that may exist, and that sometimes even lead to circumscribed spots of softening of the brain substance. This œdema usually announces itself only by a very decided weakening of the psychical functions; sometimes, however, a high degree of œdema is found in persons who, during life, have presented very severe brain symptoms. Such cases have already been narrated, and it is only necessary to add, here, that strikingly extensive œdema of the brain was found in one case of trismus and in two cases of severe general convulsions.

Among the grosser anatomical changes taking place in the brain, *effusions of blood* are the most frequent. Degeneration of the walls of the blood-vessels probably produces a predisposition to this accident, which takes place most frequently at the height of the disease. Moderate effusions of blood into the meninges of the brain usually produce no marked symptoms; more considerable effusions produce the symptoms of compression; while hemorrhage into the substance of the brain gives rise, as a rule, to the symptoms of apoplexy.

These effusions may sometimes be of traumatic origin. Such was the case in a patient who had fallen down stairs before his admission into hospital, and in another who, in an unexpected attack of wild delirium, jumped out of the window. In both cases there was effusion of blood into the cavity of the arachnoid, without any injury of the skull having been sustained. In a third patient, who had also jumped out of the window, the perivascular spaces over almost the entire surface of the right hemisphere, were filled with blood. Aside from these, Hoffmann found effusions of blood within the cavity of the cranium eight times, most frequently within the membranes. In one case the effusion was into the substance of the brain, with extensive destruction of the latter; in another it appeared as capillary hemorrhage passing into the stage of red softening. Death occurred only once during the period of convalescence, in all the others it was at the height of the disease.

Acute meningitis occurs but rarely as the result of this fever.

Hoffmann reports only 4 cases of acute meningitis in 250 post-mortems. In one case, in addition to circumscribed pulmonary gangrene, he found multiple abscesses of the brain, doubtless originating from the presence of emboli.

It is by no means rare to note the presence of uncommon psychical disturbances, without being able to demonstrate the existence of any anatomical alterations in the brain which might cause them. Sometimes these disturbances partake of the character of what are called *diseases of the mind*, and, in that case, a state of psychical depression is most likely to exist. If these conditions supervene after the entire abatement of the fever, the prospect of recovery from them is favorable; sometimes this recovery is very rapid, at other times more tardy. At the height of the disease, however, the development of such symptoms, or of any uncommon brain symptoms, must be looked upon with alarm.

Diseases of the mind may make themselves manifest at a late period of convalescence, or even long after apparent recovery, and may throw the patient into a state of extreme exaltation, or into a state of mental depression. These mental disturbances seem to be most frequent in persons having an hereditary tendency thereto. They are not peculiar to typhoid fever, but may occur after any serious febrile affection. Undoubtedly the elevation of temperature occurring in these diseases, together with the alterations produced in the central nervous system by this high temperature, bear a part in the production of the mental disturbances; sometimes merely giving an opportunity for their development, sometimes serving as a predisposing cause, and sometimes as the essential and fundamental cause of the same. I have repeatedly seen cases of this kind where confinement in an insane asylum was required for a time; in all of these the subsequent recovery was complete, and I learned of no relapses of the mental disturbance. Some instances of a less favorable termination are related by other observers.

Dr. J. Christian [1] presents us with the statistics of 114 cases of mental disease, following acute diseases. Ninety-one of these recovered; only 4 died, and 3 of these from causes not directly dependent on the mental disturbance. The duration of the psychical difficulties was accurately noted in 81 cases. In 37 of these all symptoms disappeared within 14 days (there are some cases included in this where the delirium lasted but a few hours); in 6 the duration was between 14 days and

[1] De la folie consécutive aux maladies aiguës. Archives Générales de Médecine. 1873.

1 month; in 19, between 1 month and 3; in the balance it was over 3 months. Hereditary predisposition was noted in only 10 cases, but this is evidently too low a proportion.

A condition of special interest, which sometimes develops itself at the height of the disease, has been called by me *irritation of the brain with depression of temperature.* Sometimes, about the middle of the second week, at the height of the disease, in a patient who has had continuously high temperature and the corresponding functional disturbances of the brain, the brain symptoms suddenly assume an anomalous character; they become such as to suggest meningitis; or well-marked mental disturbances appear, either partaking of the character of melancholia or with maniacal tendencies, the pupils at the same time often losing their sensitiveness to light. The striking feature of this condition, however, is that the temperature of the body, which has thus far run its ordinary course, and has for the past few days remained at about 104° Fahr., or over, suddenly falls, when the evidences of irritation of the brain appear, and, during the continuance of these brain symptoms, fluctuates in an irregular manner between 98½° and 100½° Fahr., or even between 97° and 102°. In favorable cases the brain trouble disappears in a few days, or it may not be until a few weeks have lapsed, and then the temperature rises again to a point corresponding to the stage of the disease, and the regular order of things is resumed. The number of well-developed cases that have fallen under my observation of such irritation of the brain, with depression of temperature, does not probably exceed eight or ten. It is a condition most apt to supervene in grave cases, and the irritation of the brain appears to result from the influence of a high temperature on that organ. The lowering of temperature which exists during the continuance of irritation of the brain may, perhaps, be most easily explained on the supposition that the controlling nerve-centre, which presides over the regulation of temperature, is itself involved in this irritation.

On the other hand, we may assume the existence of a disabled or crippled condition of this same heat-controlling nerve-centre, in those not very frequent cases which show an excessive elevation of temperature, running as high as 107½° Fahr., or

over. This hyperpyretic condition may, most commonly, be looked for when a considerable degree of paralysis of the brain is present (due to long-continued high temperature, or to other causes), thus presenting precisely the opposite condition to that of irritation with lowering of temperature. The extreme degree of heat indicated above justifies an absolutely fatal prognosis, and, in fact, death usually ensues in a few hours.

Aside from some instances in which the thermometer ran up to 108°, during the death agony, one case of similar hyperpyrexia is on record in a patient who had jumped out of the window during a fit of delirium. He afterwards gave evidence of profound shattering of the nervous system, accompanied by a fall of temperature; this subsequently rose again, and, before death, reached 109° in the rectum. Post-mortem examination revealed extensive hemorrhage into the cavity of the arachnoid, and breaking down of the apex of the right anterior lobe of the cerebrum, without fracture of the skull.

Every one is familiar with the danger of *fainting fits*, which may occur either in the course of the disease or during convalescence, and are liable to supervene when the patients suddenly raise themselves from a horizontal to a vertical position, and thus produce anæmia of the brain.[1] If the subjects of this accident fall to the floor, the horizontal position is usually enough of itself soon to restore the cerebral circulation. If, however, they are in such a position that they cannot fall, as, for instance, on the privy-seat, the danger is vastly augmented, and death frequently results.

In the hospital at Basle, where every precaution is taken to prevent patients and convalescents from getting up in this way, such fainting fits have, nevertheless, occurred repeatedly, sometimes followed by alarming collapse. One woman, 48 years of age, who was recovering from a mild attack of fever, who was feeling well, and had a short time before eaten a meal with evident relish, rose suddenly and went to the water-closet, where she fainted, and in ten minutes she was dead. The autopsy revealed nothing but extreme anæmia of the brain. A man who, owing to a severe attack of fever, followed by extensive bed-sores, had been obliged to maintain the recumbent position for months (in bed and in the permanent water-bath), was attacked every time, on his first attempts to sit up in an arm-chair, with nausea and vomiting, followed by severe collapse and almost complete loss of con-

[1] Compare Ueber eine besondere Ursache der Ohnmacht und über die Regulirung der Blutvertheilung nach der Körpersteilung. Prager Vierteljahrschrift. Bd. LXXXIII. 1864. S. 31 ff.

sciousness; all this in spite of his otherwise feeling well, and having almost regained his former weight and strength. He was obliged to accustom himself very gradually to the upright posture.

Finally, we may, in individual cases, encounter various other disturbances of the nervous system as sequelæ of typhoid fever, the full enumeration of which would lead us too far.[1] There are hemiplegias and paraplegias, some of which at least may be supposed to be due to central causes; besides cases of paralysis, of anæsthesia and of hyperæsthesia, confined within the domain of individual nerves. The prognosis in such cases is usually favorable, and it becomes more so in proportion as we are satisfied that no gross anatomical changes are at the foundation of the functional disturbance.

V. *Genito-Urinary Organs.*

The usual alterations in the kidneys, consisting essentially in parenchymatous degeneration, have already been noticed, and it was stated at the same time that *albuminuria* frequently occurs in the course of typhoid fever, but that this symptom may sometimes be absent, even when a considerable degree of degeneration exists. The albuminuria usually disappears soon after the abatement of fever, and even the degeneration of the renal epithelium seems to leave no lasting changes behind it.

Griesinger found albuminuria, at least the transitory form, in about one-third of his cases; and about the same proportion is reported by Murchison.

Acute Bright's disease is occasionally developed as a sequel of typhoid fever, appearing usually during convalescence, but exceptionally during the continuance of fever. The urine is heavily loaded with albumen (to the extent of one per cent. or over), and usually contains some admixture of blood; tube-casts are found in the sediment, covered with epithelium, or fragments of the same; the secretion of urine is sometimes quite scanty, and a moderate degree of dropsy sets in, frequently beginning in the hands and face. Although the disease may last for many

[1] Compare *H. Nothnagel.* Die nervösen Nachkrankheiten des Abdominaltyphus. Deutsches Archiv für klin. Medicin. Bd. IX. 1872. S. 480 ff.

weeks, or even for months, I have yet to learn of an instance where it has resulted in chronic Bright's disease. Death may, however, ensue through uræmia, or through œdema of the brain or lungs. Immermann reports the cases of two patients in the Basle hospital, who died of uræmia, the result of acute parenchymatous nephritis, during the year 1872, soon after their admission to the hospital, and during the height of an attack of typhoid fever. In all the cases that I have seen myself com plete recovery has followed. The frequency of the occurrence of this acute Bright's disease is by no means so great in typhoid fever as it is after scarlatina ; it is even, in my opinion, more rare in typhoid than after measles, pneumonia, or facial erysipelas.

Hemorrhagic infarctions in the kidney constitute another complication of the fever, occurring sometimes singly and sometimes in greater numbers. In the majority of cases, cicatrization takes place, the infarction seldom resulting in abscess.

This complication was met with but ten times in Hoffman's post-mortems. In most of these degeneration of the muscular tissue of the heart was very considera ble, and in several of them old, firmly impacted heart-clots were found. In several, also, there were evidences of embolism elsewhere, so that the renal infarctions could with justice be attributed to emboli originating in the left heart.

During convalescence I have occasionally seen an *acute catarrh of the bladder* spring up with considerable violence, but end in speedy recovery. Slight and transitory catarrhal manifestations, or symptoms of irritation and hyperæsthesia of the bladder, are quite frequent during convalescence. It should also be mentioned that pyelitis and severe ulcerative forms of cystitis sometimes appear as sequelæ.

As regards the complications that affect the genitals, it may be remarked, first, that any virulent ulcers existing upon them, may, under the influence of a severe typhoid, result in extensive destruction of tissue, as was proved in certain cases that have already been narrated.

In men *orchitis* or *epididymitis* sometimes supervenes during convalescence, without the previous existence of gonorrhœa. All the cases that I ever saw ran a very light course.

Only 3 cases of orchitis are on record, in the history of 200 male typhoid-fever patients, during 1869 and 1870. The statistics of the previous years are not accurate in this particular, but, as far as I can judge, the proportion is about the same.

In women, the premature appearance of menstruation is not uncommon, and sometimes other insignificant hemorrhages occur. More serious *metrorrhagia* is usually dependent on the occurrence of labor or of abortion. The considerable loss of blood accompanying abortion or premature labor may prove of advantage, in so far as it often materially lowers the temperature, and is followed by an amelioration of those symptoms which depend on the pyrexia. As a rule, however, this improvement is only temporary, and the subsequent condition of the patient is made worse rather than better by the loss of blood.

In one case, under my observation, of an abortion with great loss of blood (about a pound and a half), the temperature in the axilla fell from 104.5° Fahr. to 97.5°, during twelve hours, the patient being at the time in a profuse perspiration. Her general condition seemed excellent, aside from the weakness necessarily incident to the case. She had lost all her despondency, and all feeling of being sick. But, in the course of twelve hours more, her temperature had again risen to 104.5°. Nevertheless the case terminated favorably.

In two of those cases which died after labor or abortion, the autopsy revealed ichorous degeneration of the inner walls of the uterus; in several more, diphtheritic endometritis was found.

In one instance serious hemorrhages were found in the ovaries, not dependent on pregnancy or parturition; and, in another, purulent degeneration of one ovary existed.

VI. *Skin, Connective Tissue, Muscles.*

Aside from the eruption of miliaria and roseola, already described, various other exanthemata may appear.

Several authors describe an eruption, under the name of *taches bleuâtres* or pelioma typhosum, consisting of larger or smaller bluish-red spots on the trunk and on the extremities, which may appear at any stage of the disease in both severe and mild cases.[1] These may also be found in connection with other diseases.

[1] Compare *Murchison*, l. c. p. 474, and Plate V.—*Gerhardt*, Deutsches Archiv für klin. Medicin. Bd. XI. 1873. P. 4 ff.

In some cases that I have seen, a *diffuse erythema* has appeared, in the course of the first week, most commonly on the neck and forearm, but sometimes on other parts. Occasionally this has been so diffuse that it caused doubt for a little while, especially when the patient had sore throat, whether one might not be dealing with a case of scarlet fever. This eruption afterwards disappeared, and the disease ran its ordinary course. So far as I remember, these were all severe cases.

Erysipelas faciei most frequently occurs during convalescence; seldom at the height of the disease. It may prove dangerous by producing renewed fever.

In 1,420 cases of fever, at Basle, erysipelas appeared 10 times, all of which resulted favorably. In two other patients, with severe bed-sores, erysipelas was developed about the wounds. Griesinger has found erysipelas to occur in about 2 per cent. of the fever patients.

Herpes labialis or *facialis* is rare, and in cases of doubtful diagnosis may be considered as rather furnishing evidence against the existence of typhoid fever.

In Basle, the presence of this eruption was more frequent than it usually is, being found 56 times among the 1,420 patients (4 per cent.). In only two of these could the herpes be attributed to the presence of pneumonia as a complication. It appeared, at first, as if herpes attacked only the milder cases, and might thus be considered as a favorable prognostic; this was, however, not confirmed in the end, 10 of the 56 cases terminating fatally (18 per cent.), and only 11 running a mild course.

Hemorrhages into the skin, true petechiæ, vibices, etc., are most likely to exist in patients of a hemorrhagic diathesis, though they occasionally appear in others.

In Basle they were observed 12 times in 1,420; three of these were subjects of a general hemorrhagic diathesis; these three, as well as two others, died.

Furuncles and *abscesses* in the skin, in the subcutaneous cellular tissue, in the muscles and the inter-muscular tissue, are met with very often, most commonly at a late period of the disease or during convalescence. They are most readily developed at such points as have been subjected to continuous or frequent pressure, as the back and buttocks, and may, under some circumstances, prove to be the beginning of bed-sores. Muscular

abscesses are most frequent in the region of the glutæi and gastrocnemii muscles, less so in the latissimus dorsi or in other regions.

Such abscesses were found at Basle 85 times among about 1,750 patients. In one instance death was caused, at the end of three weeks, by the presence of a large number of abscesses, larger and smaller. This was the only instance, however, where they were the direct cause of death. In two cases that recovered, large pieces of muscle were drawn out of abscesses in the glutæus maximus, which pieces, although entirely separated from the surrounding tissue and somewhat degenerated, were, on the whole, very well preserved.

Among the suppurative processes that are met with only in exceptional cases, we may mention *retro-pharyngeal abscess*, *periproctitis*, and the like. *Suppuration of the lymphatic glands*, particularly those of the axilla, is quite common during convalescence. I have never seen true pyæmia with multiple metastatic abscesses, in a case of typhoid fever. It may here be remarked that pyæmia is of very rare occurrence even on the surgical side of the Basle hospital.

In a young girl, recovering from the fever, a large portion of the septum between rectum and vagina sloughed off in one piece; the large recto-vaginal fistula thus produced, healed and closed completely without an operation. A woman, 74 years of age, died in consequence of a large abscess between rectum and vagina, which perforated into the rectum and led to profuse hemorrhage.

Bed-sores constitute one of the most frequent and most dangerous sequelæ of typhoid fever. They are developed by preference, at those points which are most subject to pressure, in the ordinary position of lying on the back; therefore, over the sacrum and the nates, sometimes, also, on the heels and the shoulder-blades. If the patient lies on his side, the trochanters and the crest of the ileum are most likely to suffer; if on his belly, the anterior superior spinous processes of the ileum and the knees. There are patients in whom every spot that is subjected to even moderate pressure becomes gangrenous; thus I have seen bed-sores situated on the elbows, on the back of the head, on the ears, and on the cheeks. Bed-sores are correctly defined as gangrene resulting from pressure. At the same time, it must be remembered that patients not suffering from fever

(nor from affections of the spinal cord), may lie abed for a long time without developing any tendency to bed-sores; thus proving that ordinary pressure will produce bed-sores only when the influence of the fever has especially predisposed the skin to gangrenous processes. The causative influence of the fever is further demonstrated by the fact that, as long as high fever persists, bed-sores usually refuse to heal, and continue to spread, in spite of all therapeutical measures, whereas, with the abatement of fever, they soon show a tendency to heal. Two instrumentalities combine to bring about this controlling influence of the fever, to wit: the elevated temperature and the lowering of the force of the circulation. This last circumstance explains the especial frequency of bed-sores in persons who have suffered from intestinal hemorrhage, and the frequent coexistence of bed-sores with hypostatic consolidation of the lungs.

In the lightest cases bed-sores consist in a mere superficial loss of substance of the cutis; in those of a graver character, the skin and the subcutaneous cellular tissue are involved; while in the worst the fasciæ are perforated, and the muscles themselves implicated in the general breaking down of tissue. Over the sacrum, the trochanters and the crest of the ileum, the ulceration often penetrates to the bone, and even sometimes involves portions of the periosteum. Sometimes the destructive process extends further in the deeper parts than on the surface, and then we may see extensive undermining, with subcutaneous collections of pus or ichor. I have seen cases where the connective tissue and muscles had undergone ichorous degeneration over almost the entire region of the back, while the skin was destroyed only over the sacrum; and others in which the trochanters were denuded, and the destruction extended to a great part of the muscles of the nates and thigh. The early history of bed-sores differs with the different varieties. In the simplest cases, the first thing observed is an erythema, appearing at the point of pressure; then the epidermis is loosened in spots, the cutis is gradually encroached upon, and finally the ulceration penetrates to deeper portions. At other times, the first manifestation consists of furuncles, or little abscesses in the skin similar to furuncles, which do not heal after discharging, but extend, become

confluent, and finally deepen. The worst form of bed-sores begins with considerable spots or areas of hemorrhage. A bluish spot is seen through the skin, and a corresponding firm, hard swelling may be felt; these are due to a hemorrhage into the subcutaneous cellular tissue and deeper parts. The spot soon afterwards becomes of a dark bluish red, and, within a few days after the appearance of the first manifestations, a large portion of the skin and the tissues beneath it are transformed into a gangrenous slough, which rapidly continues to break down. A rarer form than any of those hitherto mentioned is that where an extensive dry gangrene appears at the points of pressure, the skin and a part of the subjacent structures becoming black and mummified.

There was a tendency among some of the older physicians to look upon bed-sores as a favorable sign, rather indicative of the attainment of a crisis in the disease, and they based this view upon the well-known fact that improvement is very likely to show itself about the time of their appearance. This, however, is very easily explained; bed-sores usually make their appearance during the third or fourth week, at a time when the fever, having already lasted long, has made a profound impression on the system, but a time, also, when in the natural course of the disease, a diminution in its intensity is to be expected, which would no doubt take place even more surely in the absence of these sores. This complication, indeed, is always a very unfavorable one, and it is the more so when, owing to its extension, it becomes, itself, a new source of fever, and the fever thus produced in turn reacts on the sore and causes its still further enlargement. A large number of patients, who have lived through the fever, actually die from the effect of bed-sores and their consequences. This complication is the more dangerous the earlier it appears; that is to say, the longer a high grade of fever persists after its appearance.

Among 1,743 typhoid-fever patients at Basle, bed-sores appeared in 159 ($9\frac{1}{10}$ per cent.). Fifty-nine of these died, being 37 per cent. of the number attacked. In 100 cases the period of the first appearance of the sores was carefully noted, being 25 during the second week, 30 during the third, 27 during the fourth, and 18 at a later period.

As this complication is so particularly dependent on the fever, we should naturally suppose that systematic antipyretic treatment would exert a marked influence in lessening its frequency and moderating its intensity, and such, in fact, we find to be the case. In 861 typhoid-fever patients treated before the introduction of the use of cold water, 88 had bed-sores, 36 of whom died. In 882 cases treated with cold water, 71 had bed-sores, 23 of whom died. In other words, the former record gives a frequency of occurrence of $10\frac{2}{10}$ per cent., and a mortality of 41 per cent. of this number; the latter record a frequency of $8\frac{1}{10}$ per cent., and a mortality of 32 per cent. of this number. These figures, however, do not illustrate the full benefit to be derived from the cold-water treatment, inasmuch as, under its use, it is especially the frequency of the severe cases that is so materially diminished.

Gangrene of the skin, at points where no pressure has been brought to bear, is rather rare. Aside from those cases where gangrene results from previously existing ulceration, I have only met with four cases of partial gangrene of the skin of the toes. The influence of defective circulation makes itself felt the most in these peripheral parts. It must also be remarked that all four of these cases occurred after the treatment with cold baths, and it seems not improbable, as Jürgensen[1] also thought, with regard to one of his patients whose toes became gangrenous, that the contraction of the arteries produced by cold may have had a share in causing the gangrene.

Falling off of the hair is one of the most common sequelæ of the fever, and may be considered the rule in severe cases. It usually takes place from the fourth to the eighth week of convalescence, and before it is complete the new hair begins to come in, which is, at first, quite crisp and lustreless, but gradually assumes a natural appearance.

After severe attacks the nails also show changes,[2] that part of the nail which grew during illness being either dull and without polish, or white, or more or less thinned. The bands or fur-

[1] Klinische Studien über die Behandlung des Abdominaltyphus mittelst des kalten Wassers. Leipzig, 1866. S. 33.

[2] Compare *A. Vogel*, Die Nägel nach fieberhaften Krankheiten. Deutsches Archiv für klin. Medicin. Bd. VII. 1870. S. 333.

rows thus formed across the whole width of the nails naturally move forward with the growth of the latter, and, by noticing their position, one can make an approximate guess of the length of the time that has intervened since the illness. The same changes in the nails may also be found after other severe febrile affections.

In consequence of the friability of the muscular tissue resulting from degeneration of the same, *rupture of muscles* is an accident that occasionally takes place, often accompanied by hemorrhage.

Hoffmann found 11 instances of rupture of the muscles in 250 autopsies; 6 of these were in the rectus abdominis (twice being bilateral), the others in the transversalis, pectoralis minor and psoas. It is possible for the ruptured muscle, with a somewhat extensive hemorrhage, to result in suppuration and death, such a case being reported by Zenker (l. c. p. 93) as occurring with a rupture of the rectus abdominis.

Those processes of suppuration within the muscles, whereby, sometimes, large pieces of muscle are, as it were, dissected out and thrown off, have already been noticed. Zenker agrees with me in the opinion that the previous degeneration of the muscle plays an important part in the production of these abscesses.

VII. *General Disturbances.*

It is by no means a matter of surprise, in view of the extensive lesions that have existed in the intestinal canal and the mesenteric glands, to say nothing of various other disturbances of the body, that, in many cases of recovery from typhoid fever, a long time should elapse before the general nutrition of the body is restored to its normal standard. Still, in almost all the cases that terminate favorably, the general health is gradually completely restored. A very singular phenomenon is presented by the fact that, once in a while, a person who has gone through a severe attack of the fever entirely changes his constitution; that is to say, one who was formerly lean develops a permanent tendency to corpulence, or *vice versâ*, or the temperament and disposition are entirely changed. When we consider the exten-

sive disturbances that take place in almost all organs of the body, during the course of the fever, perhaps such changes of constitution, resulting therefrom, ought not really to surprise us; but in view of our limited knowledge of the causes that underlie variations in constitution, it is at least certain that these phenomena are beyond our comprehension.

It sometimes happens that a patient does not return to his ordinary standard of health and nutrition, but that the typhoid condition is followed by one of progressive *marasmus*. This is especially the case in very old people, in whom, perhaps, a previously existing marasmus senilis is accelerated in its progress by the fever. Aside from these, however, it must be admitted that cases of marasmus following typhoid fever, without any special local disease, are to be ranked as amongst the greatest rarities.

Careful examination will usually detect the cause of the progressive atrophy in a newly developed pulmonary phthisis, a hidden centre of suppuration, or an inflammatory process in some internal organ, and even if such are not capable of demonstration, the persistence of fever indicates that local mischief is going on somewhere. I do not remember having seen a single instance where simple, general marasmus, without any local disease, ever led to death, though I do not mean thereby to deny that such a thing might happen.

One of the most pernicious of the general disturbances is the *hemorrhagic diathesis*, which occasionally develops itself at the height of the disease. Its manifestations consist in a general tendency to bleeding; so that, in addition to petechiæ and ecchymoses of the skin, there are hemorrhages from the mucous membrane of the stomach and bowels, nose-bleed, oozing of blood from the gums, hæmoptysis, hæmaturia, ecchymoses on the serous surfaces, hemorrhage into serous cavities, meningeal and cerebral hemorrhages, etc.

It is customary to attribute the hemorrhagic diathesis to what is called dissolutio sanguinis. A more proximate cause may be found in diseased conditions of the smaller blood-vessels, and especially in the extensive degeneration of the same, which, however, does not exclude the theory of original blood-changes, lying

at the foundation of these degenerations. The highest degree of asthenia usually exists, or is soon developed, and death speedily ensues with evidences of paralysis of the heart.

The general hemorrhagic diathesis, fully developed, only showed itself three times at Basle. Lighter degrees of it, manifesting themselves by a special tendency to bleeding at the nose, from the gums, the bronchial tubes, the bowels, etc., are more common, and may also materially increase the gravity and danger of the original disease.

VIII. *Relapses.*

We have already seen, in a previous chapter, that it is not uncommon during the course of typhoid fever for the disease to take a fresh start, accompanied with new infiltration into the lymphatic apparatus of the intestine and the mesenteric glands, and with an increase of fever.

If such a train of events transpires after the disease has run its course, that is, after the patient has been entirely free from fever, it is to be regarded as a genuine relapse. It is often difficult to determine, especially at first, whether a new onset of fever is due to a relapse or to some local affection, and it is at least advisable not to pronounce it a relapse until one has convinced himself, by the most careful examination, of the absence of any demonstrable complication. The characteristic manifestations of typhoid fever often reappear again later, more or less decidedly, and then a positive diagnosis is easily made.

For those brief paroxysms of fever which are not relapses, and not dependent on any local disease, it may be as well to adopt the name given them by Biermer, who calls them "after-fever."

The course of a relapse corresponds with that of a regular attack of the fever, except that it is usually shorter. Thus the temperature in the onset rises more rapidly. Roseola and swelling of the spleen occur sooner, and the entire duration of the fever is more brief. Accordingly, the prognosis is, in general, better, though, on the other hand, the circumstance that the patient is enfeebled by the previous attack, makes it less favorable.

In the hospital at Basle, 1,743 typhoid-fever patients had 150 relapses; they occurred, therefore, in 8,6 per cent. of the cases. According to a collection of cases

made by Gerhardt,[1] from reports of epidemics, it appears that in 4,434 cases of typhoid fever there were 280 relapses; or $6\frac{3}{10}$ per cent. Bäumler[2] had 8 relapses in 73 cases of the fever, that is, about 11 per cent.; Biermer[3] only 37 unequivocal relapses among 1,138 patients, or $3\frac{3}{10}$ per cent. Among the 150 cases reported at Basle, 4 were instances of double relapse; among the 280 of Gerhardt, 12 were double.

Taking 111 of the cases that occurred at Basle with simple relapse, the fever was of longer duration during the first attack than during the relapse in 68 cases; in 6 the duration of the two was alike; in 37 cases the fever lasted longer with the relapse than with the original attack. According to a somewhat loose estimate, it was considered that the original attack, in these 111 cases, might be reckoned as mild in 29 of them, as severe in 82; the relapse was mild in 47, severe in 64, seven of whom died. The period of freedom from fever, between the first attack and the relapse, lasted 4 days in 27 cases, from 5 to 7 days in 17 cases, from 8 to 14 days in 35 cases, 15 days or over, in 32 cases.

The same complications and sequelæ are liable to occur with relapses as with the original fever. In 115 relapses at Basle, intestinal hemorrhage occurred 4 times; perforation, twice; thrombosis, once; consolidation of the lungs, 9 times; epistaxis, 7 times; bed-sores, 4 times; abscesses, 5 times; petechiæ, 3 times.

The opinion has repeatedly been advanced, that relapses are more frequent under the cold-water treatment. In Basle, before the introduction of this treatment, 861 typhoid-fever patients gave us 64 relapses, or $7\frac{4}{10}$ per cent., 2 of which were fatal; after the introduction of this treatment, 882 typhoid-fever patients gave 86 relapses, or $9\frac{8}{10}$ per cent., 10 of which proved fatal. It appears, therefore, that the proportion of relapses and the number of deaths are both actually increased under the use of cold water. It does not, however, necessarily follow that this treatment favors the occurrence of relapses. In the first place, before the introduction of this treatment, many more typhoid-fever patients died in the first attack of the disease; we should, therefore, only employ those cases for statistical purposes in which the patients have survived the first attack, these being the only ones in which a relapse is possible. Adopting this plan, the difference at once diminishes; we find 9 per cent. of relapses before the use of cold water, and $10\frac{3}{10}$ per cent. after its use. And when

[1] Deutsches Archiv für klin. Medicin. Bd. XII. 1873. S. 8.

[2] Deutsches Archiv für klin. Medicin. Bd. III. 1867. S. 393 ff.

[3] *S. O. Fleischl.* Ueber Recidive und Nachfieber beim Abdominaltyphus. Dissertation. Zurich. 1873.

we take into consideration the fact that it is just in the severe cases, which would die without the antipyretic treatment, that the greater number of relapses occur, perhaps the difference may entirely disappear. It is difficult to determine even what degree of weight should be attached to the circumstance of the greater mortality of relapses under the cold-water treatment. One of the ten cases of death reported after the introduction of this treatment, had been carried through his first attack without the use of the cold baths, and should, therefore, have been placed in the other group. And, seeing that the relapse is most likely to take place in the graver cases, the difference in mortality might be accounted for by the survival, under antipyretic treatment, of a larger number of these graver cases, after the first attack. The question, therefore, whether the use of cold baths favors the occurrence of relapses, is a considerably complicated one, and one to which the facts now in our possession do not enable us to give an unequivocal answer. At present the probability certainly seems to be in favor of the affirmative of the question, the more so as it appears that the frequency of relapses is greater in proportion as the antipyretic treatment has been the more systematically employed. If we take the reports of the years 1869, 1870, and 1872, at Basle, we find, among 467 typhoid-fever patients systematically treated with cold baths, 33 deaths, and 55 relapses, 6 of which were fatal; the frequency of relapses, therefore, counting only those patients who had survived the first attack, was in the proportion of $12\frac{5}{10}$ per cent., as against 9 per cent. before baths were used. The higher rate of mortality among the relapses is of so much the greater import, in view of the fact that the relapses, too, were treated antipyretically, which ought rather to have given us a lower death-rate.

Biermer (l. c.) has also found the frequency of relapses increased since the introduction of cold baths. Leichtenstern,[1] on the contrary, met with only 4 cases of undoubted relapse among 243 patients so treated.

As the course of a true relapse is essentially the same as that of a primary attack of typhoid fever, and especially inasmuch

[1] Ueber Abdominaltyphus. Dissertation. München, 1871. S. 36.

as the same alterations are produced thereby in the intestines, the mesenteric glands, the spleen, and the skin, there can be no doubt that the same poison is present in both instances, developing itself and working in the body in the same way. Where this poison comes from, is still an open question.

It has been held that all relapses depend on a new infection, and if the patient, during his illness, remains at the place where he originally acquired the infection, it is certainly possible that he may have been again poisoned from the same source. Furthermore, if the first attack was of quite brief duration, and the second very soon followed, it may be possible, in view of the long period of incubation of this disease, that the second infection took place before the first outbreak of fever. But in many cases none of these conditions exist. When a patient, on being first attacked, is transferred to a hospital, where all sources of infection are most carefully guarded against; when he there goes through the regular course of typhoid fever, lasting its usual time; when, after being entirely free from fever for one or more weeks, he then becomes the subject of a relapse, it is certainly in the highest degree improbable that this relapse is due to a new infection. Such were precisely the conditions presented by the great majority of the patients at Basle. We are, therefore, forced to the conclusion that relapses are usually due to the same infection that caused the original attack. Part of the poison, then, must have remained latent somewhere in the body, not developed during the first attack, not destroyed nor expelled, and not beginning to mature and to assert itself until afterwards. If relapses are more frequent under antipyretic treatment, it seems natural to conclude that this treatment in so far interferes with the normal course of the disease, as to retard the development, destruction, or expulsion of the poison as a whole, or entirely to prevent these changes in a certain portion of the poison.[1] Gerhardt (l. c.) makes a statement of considerable interest as bearing upon this theory, viz., that in many cases in which a relapse takes place the enlargement of the spleen is not at all diminished during the non-febrile period that

[1] Compare *Lindwurm*, Ueber Typhus-Recidive und Typhus Infectionen. Aerztl. Intelligenzblatt 1873. Nos. 15 und 16.

intervenes between the original attack and the relapse. In many instances relapses are brought on by indiscretions in diet, especially by over-eating or indulging in indigestible viands; and sometimes by getting up too soon. But they also occur under circumstances where all indiscretions and over-exertion are most carefully guarded against, as, for instance, in a hospital. As a matter of course, the injury produced by any such means can only serve as an exciting cause to the processes that follow, stimulating the development of germs which would otherwise have remained dormant for a time, or which might even have been eliminated from the body.

TREATMENT.

Griesinger, l. c.—*R. Köhler*, Handbuch der speciellen Therapie. Bd. I. 3. Aufl. Tübingen, 1867. S. 1. ff.—*L. Stromeyer*, Ueber die Behandlung des Typhus. 2. Ausgabe. Hannover, 1870.—*James Currie*, Ueber die Wirkungen des kalten und warmen Wassers als eines Heilmittels im Fieber und in anderen Krankheiten, etc. Uebersetzt von *Michaelis*. Leipzig, 1801. Zweiter Band. Uebersetzt von *Hegewisch*. Leipzig, 1807.—*E. Brand*, Hydrotherapie des Typhus. Stettin, 1861.—*Th. Jürgensen*, Klinische Studien über die Behandlung des Abdominaltyphus mittelst des kalten Wassers. Leipzig, 1866.—*C. Liebermeister* und *E. Hagenbach*, Aus der medicinischen Klinik zu Basel. Beobachtungen und Versuche über die Anwendung des kalten Wassers bei fieberhaften Krankheiten. Leipzig, 1868.—*H. Ziemssen* und *H. Immermann*, Die Kaltwasserbehandlung des Typhus abdominalis. Leipzig, 1870.—*O. Leichtenstern*, Ueber Abdominaltyphus. Dissertation. München, 1871.

PROPHYLAXIS.

We are already familiar with a good many examples of what prophylactic measures can accomplish in the prevention of typhoid fever, and it is to be hoped that our knowledge of this subject will soon be greatly extended. Properly speaking, the study and enactment of prophylactic measures belong within the domain of Public Hygiene, or State Medicine, and typhoid fever is one of the diseases best calculated to test the efficacy of whatever precautionary enactments may emanate from that source.

The ways and means by which we are able effectively to prevent the rise or spread of this fever may be directly deduced

from what has been stated in a previous chapter, with regard to its etiology, so that we shall here content ourselves with a reference thereto and the addition of a few practical details.

It may be stated in general that prophylactic measures will be effective just in proportion to the strength of our belief in the material nature of the typhoid poison, and in the possibility of destroying it or preventing its spread. Here, as elsewhere in therapeutics, half-way measures, such as are likely to be employed by those who have but little faith in their efficacy, yield, not half-way results, but no results at all.

A sufficient method of preventing the occurrence of an epidemic of this disease, in a place where it had never existed, would be to guard against the introduction of any cases from without. This, however, cannot be practically carried into effect; and as the fever is already endemic in almost all large places, and especially in all cities, it is, of course, entirely inapplicable to them. A measure of the greatest importance, however, for small places where the malady is not yet endemic, and for individual houses and groups of houses in larger places, is, to a certain degree, to isolate any case of the fever that may be imported, both for the purpose of preventing the spread of the same and of guarding against the establishment of a centre of infection. By this it is not meant that the individual himself shall be isolated, as in case of small-pox; this is neither necessary nor would it answer the purpose; the only essential point consists in the proper treatment of the dejections. These must be disinfected in the most thorough manner, and should *by no means* be thrown into privy-vaults, upon dunghills, or other similar places. As a rule, I have a porcelain bedpan used, the bottom of which is strewed, each time before being used, with a layer of sulphate of iron; immediately after a passage, crude muriatic acid is poured over the fæcal mass, as much as one-third or one-half of the bulk of the latter being used for that purpose.

Where it is practicable, the contents of the bedpan should be emptied into trenches, dug anew every couple of days, and filled up when discarded, care being taken that they are not located anywhere in the vicinity of wells. Where nothing else can be done, the dejections will, of course, have to be emptied

into the privy-vaults, in which case they should be even more thoroughly covered with the crude acid. Any of the under-clothing or bed-clothing that is soiled during stools should be immediately immersed in water, or in a solution of chloride of zinc, and should be thoroughly boiled within twenty-four hours. I have employed this same method with cholera patients who were admitted to the hospital (exercising the same care with the matters vomited), and no spread of the disease ensued. If the physician is supported by tolerably intelligent attendants, he may give the fullest guarantee that no extension of the malady will ensue from a single case.

When an epidemic exists, or in places where typhoid fever is constantly present, the points that should receive the greatest attention are those that relate, first, to *drinking-water*, and second, to *privies*.

The importance of securing drinking-water which is guarded against every possibility of infection, is getting to be so generally recognized, that the time is probably not far distant when every city with any enterprise or public spirit will see to it that it is thus supplied. At present, however, and until this is the case, the utmost vigilance must be maintained to avoid impurities. Suspected wells should be closed by the police, the public should be warned against the danger of using unsafe or suspicious water, without having first boiled it. It may here be remarked that even the use of artificial mineral-waters gives no guarantee of security, since every sort of well-water may be employed in their preparation, without any previous purification.

As regards the ultimate removal of fæcal matter, there can be no doubt that the best method in use, thus far, in a sanitary point of view, is a thorough system of sewerage properly flushed with water. The extensive statistics of numerous English cities abundantly prove that the frequency of the occurrence of typhoid fever is materially reduced by the adoption of effective and systematic flushing of the sewers. But it is generally conceded that this method is not practicable under all circum stances and for all places, and that a thorough system of sewerage, without the necessary water privileges, is also worth much in a prophylactic point of view.

But where, as is thus far the case in almost all German cities, neither the one nor the other method is thoroughly carried out, much can still be done to suppress an epidemic that is just beginning, or to restrict the limits of one that is fully developed, by the frequent emptying of privy-vaults and thorough disinfection. In the fall of 1867, when cholera was widely spread in Zurich, the city of Basle inaugurated the most complete and systematic method for the disinfection of privies, the flushing and disinfection of sewers, etc. At all taverns, boarding and lodging houses, schools, etc., the labor of disinfecting was done by men appointed by the police, and it was repeated daily; and all privies in private houses were similarly cared for by the police once or twice a week, irrespective of whether those living there used disinfectants about them or not. The city remained free from cholera, although constantly maintaining the most lively intercourse with Zurich, and with a number of other places where cholera prevailed; but of course it cannot be positively determined whether such immunity was due to the precautions taken, or was merely the result of chance. During this period, however, the frequency of typhoid fever was also notably diminished. During the six months from November, 1867, to April, 1868, only thirty typhoid-fever patients were admitted into the hospital; whereas, taking the average of the preceding ten years, the number usually admitted during these six months was one hundred and thirty.

The same points that are to be observed in larger epidemics should also be kept in view in house-epidemics, or wherever a number of cases of any disease occur that indicate the existence of some centre of infection. If careful and thorough search is made, we shall be able, in the great majority of cases, to determine, with more or less certainty, on the original source of infection, and to institute measures for the removal of the same.

SPECIFIC TREATMENT.

Inasmuch as typhoid fever is a disease which is generated by a specific poison, the supposition that a specific antidote might exist, and the consequent search for the same, are not as absurd

as people thought them during that period when all therapeutic wisdom was supposed to have culminated in the expectant plan of treatment. The fact that other specific diseases, such as syphilis and those of malarial origin, are cured by specific means, and that, furthermore, many parasites are killed in the same way, justifies the hope that further search and investigation will succeed in discovering other specific remedies for given diseases. But we certainly have a right to demand that in this search for specifics, as well as in all other scientific investigations, due caution and good judgment be used. The opposite of this has so often been the case, so many articles have been heralded as specifics, because some one had treated a few patients with them, who didn't happen to die, that every claim of the kind is received with a certain degree of justifiable skepticism.

Most of the means that have been recommended as sure cures of typhoid fever, hardly retain even a historical interest. Thus venesection, with which it was long believed that the fever could be cut short, is now hardly ever employed. The same is true of emetics. No educated physician, nowadays, expects a cure from the use of chlorine-water or the mineral acids. Neither sulphate of magnesia nor carbolic acid have given any uniformly successful results. The fever cannot be aborted by the use of quinine and digitalis, as was claimed in France, nor by quinine alone, even when given in very large and frequent doses. The admirable investigations of Binz did well-nigh establish the claim of quinine to be considered as a specific in all infectious diseases. Except in malarial diseases, however, it appears that this influence, if indeed it does exist, cannot be obtained short of doses that may not be used with the human family. My own experience, at least, after treating more than 1,500 cases with quinine in doses that would formerly have been considered as dangerous to life, gives no results that would indicate any specific influence of this drug over typhoid fever, nor any power to cut the fever short at any stage. The same thing may be said with regard to the cold-water treatment. At the same time, quinine, digitalis, and the abstraction of heat by cold baths are among the most important antipyretic agencies, and are positively indispensable to the effective treatment of the fever.

Amongst all the remedies of which I can speak from personal experience, there are but two whose specific influence over typhoid fever I would not positively deny, and these are iodine and calomel.

The treatment of this disease by means of iodide of potassium has been repeatedly advocated by Sauer [1] since the year 1840. Other physicians, here and there, tried a similar method, but, on the whole, his recommendations seem to have attracted the attention of the profession but little. In the year 1859, Magonty [2] claimed the treatment with a solution of iodine and iodide of potassium as new and original, and von Willebrand [3] advanced the same claim in 1866. The latter used a solution of one part iodine, two parts iodide of potassium, and ten parts water, giving three or four drops in a glass of water every two hours. I have used iodine in this form myself; also sometimes in the form of iodide of potassium, in doses of a scruple to a drachm during the twenty-four hours.

In more than 200 cases in which I used it, as above, the iodine did not produce any marked effect on the course of the fever. Neither the diarrhœa nor the intestinal symptoms generally seemed in any degree the worse, and in some cases they seemed even to be improved thereby. No effect was apparent on the mucous membrane of the respiratory apparatus; coryza never occurred, except in one very light and abortive case; neither was an unequivocal iodine eruption ever seen. The temperature showed no well-marked departure from the ordinary course. In fact, looking at the individual cases, as they occurred, it was impossible to recognize any distinct effect from the iodine. But the mortality was notably less than in those cases treated at the same time, and in all other respects in precisely the same way, without the use of iodine. This certainly argued in favor of the beneficial effect of the remedy. The question of its value can only be satisfactorily determined by further systematic comparisons, at some point where a large amount of material for observa-

[1] Schmidt's Jahrbücher. Bd. XXVIII. S. 150. Bd. XXXVIII. S. 350. Bd. CXVII. S. 112.

[2] Nouveau traitement de la fièvre typhoïde. Paris, 1859.

[3] Virchow's Archiv. Bd. XXXIII. S. 517.

tion is at hand. An accurate comparison of those cases treated with, and those without, iodine was begun by one of my students, but unfortunately not carried out.

Calomel, in large doses, used to be given in typhoid fever, chiefly because a vigorous antiphlogistic was supposed to be needed, in view of what was considered the inflammatory character of the intestinal trouble. For this reason also, early in the disease, general and local bloodletting were combined with it. Although used and recommended by several physicians towards the close of the last century, and especially during the second decade of our own, this method of treatment did not attain much popularity until recommended by Lesser,[1] in 1830, after which it was adopted by Wolff, Sicherer, Taufflieb, Schönlein, Traube, Wunderlich, and many others. Lesser and his immediate followers gave doses of a scruple, repeated daily ; afterwards smaller amounts were given, such as ten grains, and even as small as five. Almost all observers, who have treated a large number of cases this way, are unanimous in claiming favorable results, and most of them believe that it has an influence in shortening the duration of the disease.

I have usually given calomel in doses of half a scruple, and afterwards of seven and a half grains, so as to administer three or four such doses in the course of the twenty-four hours. The first increase of the diarrhœa soon subsides, and afterwards it seems to be less. The mouth was, as a rule, affected only in those cases where it was deemed necessary to repeat the dose on successive days, and never to such a degree as to produce any serious inconvenience. In most, but not in all cases, the administration of the first doses was followed by a distinct but transitory lowering of the temperature, an observation also made by Traube and Wunderlich. On comparison of 200 cases treated in this way, with a larger number treated without calomel, but otherwise precisely alike, it appears that under the calomel treatment the rate of mortality was decidedly lower. The statements of the older observers were also confirmed in this,

[1] Die Entzündung und Verschwärung der Schleimhaut des Verdauungskanales als selbstständige Krankheit, Grundleiden vieler sogenannter Nervenfieber etc. Berlin, 1830. S. 409 ff

that when calomel was given early a strikingly large number of cases ran a much shorter course, whereas in others there was no shortening of the period of the disease. No light has, as yet, been thrown upon the question of why calomel should shorten the career of one case and not of another. It has been conjectured that perhaps the way in which the poison is taken into the body may have something to do with it. At all events, the hope that we might be able to cut short every case of the fever, by the early administration of this drug, is not confirmed. One patient, under treatment for syphilis, who was taking eight grains of calomel morning and night, became the subject of a severe attack of typhoid fever during this very time. Since the favorable effect of calomel on the large majority of cases was demonstrated, I have given this medicine, with but few exceptions, to every case of the fever admitted before the ninth day of the disease. I usually give three or four eight-grain doses during the first twenty-four hours. After having employed this method, now, on about 800 patients, I still feel that I have every reason to continue it and to recommend it to others.

The statistics relative to the effect of iodine and calomel are based on the observation of 839 cases, a part of which were treated with iodine, a part with calomel, and a part with neither, the rest of the treatment being exactly alike in all of them, and consisting in the employment of a partial antipyretic method.[1] The results, as regards the rate of mortality, were as follows:

	Number Treated.	Number Died.	Percentage of Mortality.
Non-specifically treated	377	69	18.3
Treated with calomel	223	26	11.7
Treated with Iodine	239	35	14.6
Total	839	130	15.5

We have, therefore, an average mortality of 13.2 per cent. under specific treatment, as against 18.3 per cent. under that which is non-specific, the two groups being otherwise handled precisely alike; and under the use of calomel we have the remarkably low death-rate of only 11.7 per cent.

[1] Bericht über die Resultate der Behandlung des Abdominaltyphus in Spital zu Basel. Deutsches Archiv für klin. Medicin. Bd. IV. 1868. S. 413 ff.

These figures, however, are not to be accepted, without further scrutiny, as representing the entire result. For, although cases, as they came in, were, on the whole, distributed to the different groups without favor, yet it was unavoidable that such as were admitted to the hospital in an entirely hopeless condition should more frequently fall into the category of those non-specifically treated. To compensate for this, on the other hand, the great majority of those in whom the disease ran so mild a course that they hardly needed any treatment from the beginning, also fell within this category. These circumstances, however, demand a more specific inquiry. We may consider that we have pretty certainly included all cases considered hopeless from the beginning, if we expunge such as died within six days of their admission to hospital. We should then have the following results:

	No.	Died.	Percentage of Mortality.
Treated non-specifically	355	47	13.2
Treated with calomel	216	19	8.8
Treated with iodine	229	25	10.9

It appears, then, that no great change is produced by eliminating the more rapidly fatal cases.

If, on the contrary, we include these and leave out the lightest ones, we have the following table:

	No.	Died.	Percentage of Mortality.
Treated non-specifically	273	69	25.3
Treated with calomel	160	26	16.3
Treated with iodine	204	35	17.2
Total	637	130	20.4

If, finally, we omit both the gravest and the lightest cases, we have:

	No.	Died.	Percentage of Mortality.
Treated non-specifically	251	47	18.7
Treated with calomel	153	19	12.4
Treated with iodine	194	25	12.9

These various combinations all yield results highly favorable to the specific treatment, and thus serve to confirm the results of the first table.

In addition to this, however, it appeared that the use of calomel *materially shortened the duration of the disease and diminished its intensity* in a large number of cases. This is shown by the following table:

Total Number.	Character of the Attack.			Percentage.	
	Severe.	Medium.	Light.	Of light Cases.	Of Medium and Light combined.
Treated non-specifically, 337	230	43	104	27.6	39.0
Treated with calomel, 223	102	58	63	28.3	54.3
Treated with iodine, 239	161	43	35	14.6	32.6

The supposition that it is the use of calomel that shortens the duration and diminishes the intensity of some cases of the fever grows into positive conviction when one examines individual instances more carefully. I have, for instance, made a comparison between fifty cases of each of the three classes hitherto referred to, selecting such as were admitted into hospital about the same time, all of whom were looked upon as grave cases in their earlier history, but all of whom recovered, and rejecting from the list all those in whom the thermometer in the axilla had not risen to 104° Fahr., or over.

The number of those who were permanently free from fever, within 11 days of their admission to the hospital, ran as follows: Of the 50 treated non-specifically, 4; of those treated with iodine, 5; and of those with calomel, 9. By the fourteenth day, the number of those who had arrived at this condition in the first class was 12, in the second class, 14, and in the third class, 20. Among those who passed the fourteenth day without the fever being broken, the influence of calomel was lost, as far as any shortening of the subsequent course of the disease was concerned; in fact, the average duration of those cases was somewhat longer than where calomel had not been used.

It is a singular fact that the effects of the calomel treatment vary according to the number of doses given. In 18 of the 50 cases above mentioned, one single dose of ten grains of calomel was administered, and, in one of the 18 patients, the disease terminated before the eleventh day; in 15 cases, two ten-grain doses were given, and 3 of these recovered by the eleventh day; in 17 cases, three or more ten-grain doses were given, and 5 of these patients recovered within eleven days. Six of the 18 with one dose, 5 of the 15 with two doses, and 9 of the 17 with three or more doses, were free from fever by the fourteenth day. I should consider these figures as merely the result of accident, seeing the total number is not large enough to base statistics on, if a similar calculation, based on somewhat larger numbers, did not give a result pointing in the same direction. One hundred and thirty-four of the 223 patients treated with calomel received one or two ten-grain doses a piece; 19 of these (14 per cent.) died. Eighty-nine patients received three or more ten-grain doses a piece; 7 of these (8 per cent.) died.

Whether the favorable action of calomel depends upon its cathartic effects, and whether, as has been supposed by some, other cathartics might serve the same purpose, I am unable to

say, inasmuch as I have access to no observations on the use of other cathartics in such cases; and I should consider it improper to pronounce judgment on such a question as this without a large number of strictly comparable experiences. It is not unreasonable to suppose, that, by the timely administration of a cathartic, some of the poison still lodged in the alimentary canal might be expelled; but there is at present, to say the least, no evidence that the action of mercury on the typhoid poison, like that of iodine, may not be specific.

SYMPTOMATIC TREATMENT.

The task proposed to themselves by the ancient physicians, in combating acute affections, was to expel or overcome the disease by means of therapeutical interference. The *indicatio morbi* was to them the most important, and often the only indication to be fulfilled; their efforts were all directed towards the discovery of specific remedies.

In more recent times the leading features in the management of acute diseases are entirely different. We know that even under purely expectant treatment these affections run their regular course, and in due time terminate spontaneously. As a matter of course, we use specific remedies whenever we have reason to believe in the existence of such; but when, as is generally the case, we are satisfied that they do not exist, for any given disease, we do not, on that account, feel as if therapeutics could render us no aid.

The disease will come to an end without any of our assistance, but the special business of the physician is to see to it that the patient outlives the disease. And this duty can often be accomplished by the application of symptomatic treatment, in its wider sense, as well as through dietetic regulations. On the one hand, we must see to it that the usual incidents of the disease, if they show a tendency to grow especially burdensome or dangerous, as well as any suspicious accidental developments, are held within check, and, so far as possible, weakened in their power; on the other hand, we must strive to maintain the patient in such condition that he shall be able to offer the longest

and the strongest resistance to deleterious influences of which his constitution is capable. Our endeavor is no longer, like that of the mariners of old, to appease the fury of the storm-god by offerings and by prayer; it is enough for us if we keep our good craft seaworthy and steer her safe 'mid rocks and quicksands; the storm will cease without our bidding when once its fury is spent.

Antipyretic Treatment.

By far the greater number of those who succumb to typhoid fever die from the effect, directly or indirectly, of the fever-heat. In the hospital at Basle, among 210 fatal cases that occurred during the years 1865 to 1868, there were 86 in which death resulted from paralysis of the heart, without any special complication (except œdema of the lungs, dependent on the paralysis), or paralysis of the brain (without any of the coarser anatomical changes being found in the encephalon). It appears, then, that 41 per cent. of the deaths are due to the direct influence of an elevated temperature. And in the remainder this same influence has a share in producing the complications or in bringing about the fatal result. If we could guard our patients against the deleterious influences of excessive animal heat, typhoid fever would no more belong among the specially dangerous diseases.

It is of comparatively little importance whether we agree with the older physicians in regarding the fever as something necessary, and in so far useful, as it serves to break up the poi son of the disease and eliminate it from the body,—a theory which could, even now, command a good many arguments in its favor,—or whether we consider it as a disagreeable and dangerous manifestation of the poison by means of which the very existence of the organism is threatened. We see the disturbing influence of the fever, and it is our first duty to endeavor so far to hold this under control as to save the organism from destruction.

The danger from the fever, in typhoid fever, has very little to do with the danger from consumption of the tissues of the body, due to increased combustion. The condition of the cadaver,

after death from this disease, must convince any one that the wasting of tissue has not come anywhere near the point where it is dangerous to life. The true danger consists in *the deleterious influence of a high temperature on the tissues*, by means of which necrobiosis of the same is brought about, manifesting itself, anatomically, as parenchymatous degeneration. Paralysis of the heart is the first in order among the conditions to be feared ; second in order is paralysis of the brain ; and third in the category come disturbances in other organs.

When once parenchymatous degeneration of the heart has reached a considerable grade, it is often too late for any treatment. The physician's task is to prevent the dangerous consequences of an elevated temperature, and to treat the fever before those consequences have ensued. It is a poor excuse for the physician, whose patient dies during the third week of typhoid fever from sudden paralysis of the heart, to justify his hitherto expectant treatment with the declaration that, up to this time, no alarming symptoms had appeared, and no indications for active interference been present. If he had observed and known the significance of the temperature, he would have foreseen the evil and might have prevented it.

The several methods by which we are enabled to lower the abnormal temperature are grouped together under the name of *antipyretic treatment*. We include, under this term, the direct cooling of the body by the energetic withdrawal of its heat, and the various dietetic and medicinal regulations and prescriptions whereby the production of heat can be limited.

The first result is accomplished by means of what is known as the *cold-water treatment*, which was first systematized and used in febrile affections, according to certain clear indications, by James Currie, during the last decade of the eighteenth century. His method, which consisted chiefly in cold affusions frequently repeated, found many followers, and was especially employed in typhoid fever. But, for some reason, it gradually fell into disuse again, and was finally almost forgotten. Only a few physicians (Hallmann,[1] von Gietl, Niemeyer, and some others) still

[1] Ueber die zweckmässige Behandlung des Typhus. Berlin, 1844.

used cold water, and they either restricted its use to a few cases, or did not venture to apply the method with that energy which alone yields truly great results. E. Brand, in Stettin, was about the only man who used cold-water treatment with the proper degree of system and vigor. His book, On the Hydrotherapy of Typhoid Fever, which appeared in 1861, although in some respects one-sided, evincing the enthusiasm of subjective conviction, rather than objective presentation and analysis of facts, was nevertheless calculated to recall attention to this method. To him belongs the credit of having incited others to a trial of this method, and of having given the first stimulus to the energetic pioneer work of such men as Bartels and Jürgensen.

The appearance of Jürgensen's work, in which the results achieved at Kiel were set forth in an impartial and strictly scientific manner, marked an epoch in the history of the treatment of typhoid fever. It appeared from this work that if the energetic withdrawal of heat from the body was to be followed by any marked results, it must be repeated as often as the temperature of the body rose above a certain point; and also that patients endured this repeated withdrawal of heat without experiencing any bad effects. The method adopted at Kiel has since then been introduced (with various unimportant modifications) into a large number of other hospitals, and has almost invariably rendered remarkably favorable results. Such is the case at Basle, Bremen, Erlangen, Griefswald, Halle, Jena, Leipzig, Munich, Prague, Würzburg, Zurich, etc. Vienna seems to be the only place where the new method will not work satisfactorily. Many surgeons have confirmed its value by observations at the seat of war and in military hospitals, while in some places it has been quite extensively adopted, even in private practice.

It is, as a matter of course, entirely immaterial in what way the abstraction of heat is accomplished, provided that a sufficient amount of caloric is actually withdrawn from the body. It will be found, however, that the different methods in vogue vary as to the ease with which they accomplish this result, and that those means are not always the most effective which seem most energetic. On the whole, those means will be found pre-

ferable which achieve the desired result with the least inconvenience to the patient.

For adult patients the full-length cold bath, of 68° Fahr., or lower, is to be preferred. The same water can be used for several successive baths for the same patient; the bath-tub remains standing full, and the water, representing about the temperature of the room, answers the purpose, without change. The duration of the bath should be about ten minutes. If prolonged much beyond that it becomes unpleasant to the patient, and may even prove a damage to him. If feeble persons are much affected by the bath, remaining cold and collapsed for a long time, the duration should be reduced to seven, or even to five minutes. A short cold bath like this, will have a much better effect than a longer one of lukewarm water. Immediately after the bath the patient should have rest; he is therefore to be wrapped up in a dry sheet and put to bed (which may with advantage be warmed, especially, at the foot), lightly covered, and given a glass of wine. In dealing with very feeble patients, one may begin with baths of a higher temperature, say 75°, although of course these will produce less effect. A method especially to be recommended in such cases, if the surroundings permit, is that recommended by Ziemssen, of baths gradually cooled down, beginning with about 95°, and adding cold water gradually until the temperature is reduced to 72°, or below. These baths should be of longer duration.

As a rule, in somewhat severe cases I have the temperature taken every two hours day and night. Whenever the tempera ture in the rectum reaches 103°, or in the axilla 102.2°, a cold bath is given. As a matter of course, however, individual peculiarities must be taken into consideration. In children, or in persons whom one has reason to suppose capable of great resistance to the influence of heat, the temperature which calls for the bath may be placed higher, say at 104° in the rectum, or 103° in the axilla. In those, on the contrary, with less than the average resisting power, it may be well to employ the bath before so high a temperature has been reached, and, according to the circumstances of the case, give a shorter bath, or a warmer one, or the gradually reduced bath of Ziemssen.

Above all things, it is important for the physician to free himself from the delusion that anything essential can be accomplished by one bath or by a few baths. Many a man who has begun their use with this idea has been prevented from continuing them, because they produced much less effect than he had expected. If the disease is obstinate, the interior of the body is but very little cooled down by a single bath, and that for but a very short time. On the one hand, the contraction of the blood-vessels causes the peripheral layers of the body to become poorer conductors of heat than before, the more so the thicker they are and the larger the amount of adipose tissue. On the other hand, during the period of the withdrawal of heat an increased production of heat partly neutralizes the influence of the same. Towards the end of the bath, therefore, the temperature in the interior of the body (for instance in the rectum) is not lower than before; and it is not until some time afterwards, when the increase in the production of heat has ceased, and when an equalization of the heat of the external and internal layers has taken place, that the temperature of the interior of the body is also materially reduced. In mild cases, and during the later period of severer ones, this lowered condition is often maintained for many hours; under severe attacks the original temperature is very nearly reached again by the expiration of two hours, and a repetition of the bath is demanded. Hence the effect of a bath, and especially the duration of this effect, is, to a certain degree, a measure of the obstinacy of the fever, and as such is of considerable prognostic importance. In very severe cases it is necessary to repeat the baths every two hours, so that twelve baths are given every twenty-four hours. In some instances that have occurred in the hospital at Basle, the number of baths required by a patient during his entire illness has exceeded two hundred!

These were especially obstinate attacks, in which the intense fever would undoubtedly have caused death had any less energetic treatment been adopted. In the majority of instances, especially if antipyretic drugs are administered at the same time, four to eight baths per diem will be found sufficient, with forty to sixty in the aggregate. I would particularly insist upon the

urgent necessity of continuing the baths during the night as well as by day, in severe cases, as often as the recurring high temperature demands it.

In children,[1] the surface of whose body is larger in comparison to their weight, the baths may be made somewhat warmer, or of shorter duration, without sacrificing the good effect. The gradually cooled baths are also of value with children. Again, we must make the baths longer and colder with fat persons than with lean ones.

The majority of patients find the cold baths decidedly disagreeable, no little persuasion and some authority on the part of the physician being required to induce them to submit thereto as often as is necessary. But even in private practice the patients and their friends are soon convinced of the benefits derived from this method, and there is then no further opposition to its use. In the later stages of the disease, when there was no such fever present as positively to demand the measure, patients have often begged for permission to take a cold bath, because they still felt uncomfortably warm. As long as the temperature in the rectum is 101½°, or over, I readily consent; if it is lower than that, I only permit a very short bath, or a cold sponging off.

Leichtenstern tells us that he has observed the effect of 1,960 cold baths in typhoid-fever patients, and that in 380 of these the temperature of the body was as high two hours after the bath as before, and sometimes higher.

The difference, with regard to the operation of the cooling process, in mild and severe attacks of disease, has been made very evident by the investigations of Ziemssen and Immermann. They found the degree of the lowering of temperature as well as the duration of the same, much greater in the mild attacks than in the severe ones. It also appeared that the degree as well as the duration of the lowered temperature was more considerable at the later stages of the disease, and that this increase in the effect of the baths shows itself later in the severe than in the mild cases. Leichtenstern also found the average lowering of temperature to be greater during the fourth than during the second and third weeks.

The time of day at which a bath is given also has an influence on its effect. Ziemssen and Immermann found the most marked lowering of temperature to be produced uniformly, by the baths given about 7 o'clock P.M.; the very time when the diurnal maximum has just been passed and a tendency to a fall of heat naturally

[1] Compare *G. Mayer*, Ueber die Anwendung der antipyretischen Methode bei fieberhaften Krankheiten der Kinder.

begins.[1] After that, the best opportunity for the application of baths is in the early morning hours, between 5 and 8 o'clock, and again between 1 and 2 P.M.

In women, according to Leichtenstern, the effect of baths is usually less marked than in men, both as to amount and duration, and this author, no doubt correctly, accounts for it by the greater development of the external layer of adipose tissue in the female sex.

Cold affusions have much less effect, according to direct calorimetric observations, than baths of the same temperature and duration, but they are much pleasanter to the patient. They are, therefore, only to be recommended when the circumstances are such as to forbid the use of any more effective method of abstracting heat; or when one desires, not so much to lower the temperature, as to produce a brisk, stimulating effect on the psychical functions or the respiration.

Cold packs are usually well borne, even by the feeblest patients, especially if one leaves the legs free below the knee. A course of four consecutive packs, of ten to twenty minutes' duration apiece, is about equivalent in effect to a cold bath of ten minutes. With children they may entirely take the place of baths.

Cold sponging, even with ice-water, seems to have but a very slight cooling power, though it may be made of some effect by frequent repetition. But it can never serve as a substitute for the bath.

Local abstractions of heat, as by cold compresses, ice-bags, etc., have no influence to speak of on the general heat of the body. But the local effect of ice-bags is often of great consequence, inasmuch as, by their long-continued application over the region of the heart or on the head, we may accomplish a local lowering of heat to a certain depth, and thus protect those organs, to some degree, from the disturbing influences of fever.

Riegel[2] has seen the general heat of the body materially lowered by laying two ice-bladders, one on the chest and one on the abdomen, and recommends this method as less debilitating than cold baths. I can easily imagine that in an especially mild

[1] Compare *Immermann*, Zur Theorie der Tagesschwankungen im Fieber des Abdominaltyphus. Deutsches Archiv für klin. Medicin. Bd. VI. 1869. S. 561 ff.

[2] Ueber Hydrotherapie und locale Wärmeentziehung. Deutsches Archiv für klin. Medicin. Bd. X. 1872. S. 515 ff.

attack of fever such an influence might be produced by this means; but in only moderately severe cases, I, as well as others, have failed to find any essential lowering of the general temperature after the continued use of two or even three ice-bags.

Leube[1] has shown that a lowering of the general temperature can be attained by the use of ice if the patient is laid on large pillows containing a freezing mixture of ice and salt of the temperature of about 14° Fahr.

By means of *cold drinks*, the swallowing of ice, cold injections, etc., the temperature of the body is lowered to about the extent of the warmth required to melt and warm these articles themselves. Although the general effect of such abstraction of heat is not very great (unless one were to introduce excessive quantities), still they have this advantage, that no such compensatory increase in the production of heat follows these internal means as there does the cooling of the external surface. A frequent repetition of cold drinks, etc., so far as it is not burdensome to the patient, is therefore earnestly to be recommended.

Hemorrhage from the bowels constitutes one of the CONTRAINDICATIONS to the use of cold baths. It is possible that the determination of blood to the internal organs, caused by the abstraction of heat, may increase the tendency to hemorrhage; and at all events, the moving of the body, be it active or passive, connected with the taking of a bath, is injurious. The same thing, of course, holds true, to a still greater degree, in case of *perforation of the bowels*. I have, thus far, ordered the baths entirely discontinued, as soon as even slight hemorrhage from the bowels occurred. *Menstruation* is not to be considered as a contraindication, except when there is no danger in the case; if the fever is considerable and does not readily yield to other means, the baths are continued. Pneumonia, hypostatic congestion, and the like, offer no reason for suspending the baths; the hypostatic troubles sometimes disappear under their use.

An important contraindication, however, is found in the existence of a high degree of *weakness of the heart's action*. When the force of the circulation is so reduced that the surface of the body is cold while the interior is very hot, there is no hope what-

[1] Ueber die Abkühlung fieberhafter Kranker durch Eiskissen. Ibidem. Bd. VIII. 1871. S. 355 ff.

ever that a further cooling of the surface will make any difference to the interior; it is much more to be feared that by such means the peripheral circulation would be still more obstructed. With less serious degrees of cardiac weakness the gradually cooled bath of Ziemssen may be employed to advantage.

In some cases the extreme obstinacy of the fever, which occasionally resists the most systematic use of baths, and, furthermore, the circumstance that some patients cannot bear a sufficiently frequent repetition of them, or that contraindications to their use may exist, combine to necessitate the employment of other means which may aid in lowering the temperature of the body. Amongst the medicines having this effect the most prominent are *quinine*, *digitalis*, and *veratrum*.

Quinine has often been recommended as a specific in this disease, but has soon been found ineffective and again been dropped. It was first applied as an antipyretic in typhoid fever, and used in proper doses, by W. Vogt[1] and afterwards by A. Wachsmuth.[2] I myself have used it as an antipyretic since 1858, but I never dared to use as large doses as are necessary for a powerful antipyretic effect, until after the communications of Vogt. Since then I have hardly treated a severe case of the fever without quinine.[3]

To adults I usually give from twenty-two to forty-five grains of the sulphate or the muriate of quinia. (I find the action of the two salts in equal doses to be alike.) *This dose must positively be taken within the space of half an hour, or, at the most, an hour.* I usually let them take a powder of 7½ grains every ten minutes until the desired amount is taken. Sometimes it is preferable to administer the salt in solution, with an acid, but I have found it just as effective when given in powder. It is useless to expect the full benefit of this dose to appear, if the dose is divided and its administration extended over a longer

[1] Ueber die fieberunterdrückende Heilmethode (Methodus antipyretica) und ihre Anwendung bei acuten Krankheiten überhaupt. Schweizerische Monatsschrift für praktische Medicin. 1859, Mai–Juli.

[2] Typhus ohne Fieber? Archiv der Heilkunde. 1863. S. 55 ff.

[3] Uber die antipyretische Wirkung des Chinin. Deutsches Archiv für klin. Medicin. Bd. III. 1867. S. 23 ff.

time. Quinine is expelled from the body rather rapidly in the urine,[1] and so, in the administration of broken doses, there is never a time when a sufficient amount of it is brought to bear at once. Even if one gives a much larger amount of it, distributed over half a day or a day, there is often hardly any effect perceptible on the temperature of the body. On the other hand, I never allow the dose to be repeated in less than twenty-four hours, and, as a rule, do not give it again under two days.

A full dose of quinine, such as is spoken of above, usually produces a loud ringing or roaring in the ears and partial deafness ; if these conditions were present before, they are greatly aggravated. Very large doses may even bring about a state similar to that of drunkenness, with unsteadiness of motion, weakness and trembling in the extremities, and a decided feeling of discomfort. These last manifestations are less frequent with sick than with well subjects. The temperature of the body falls materially, sometimes to the normal standard, and soon afterwards the frequency of the pulse diminishes and all the other disturbances dependent on the increase of heat are modified. The decline of temperature usually begins a few hours after taking the medicine and the minimum is reached from six to twelve hours after ; then it begins gradually to rise again, but usually remains somewhat lower than before even as late as the second day.

There are still a good many physicians who have a sort of dread of these large doses of quinine. Where a dose of thirty grains is indicated, they give fifteen, and then try to make good the deficiency by repeating it oftener, say every day or twice a day. No sufficient and satisfactory result need be looked for from such a method. I have given quinine in large doses to at least 1,500 typhoid-fever patients, besides hundreds of patients with pneumonia and other diseases. The number of single doses, of one scruple to forty-five grains, which I have ordered, in hospital and private practice, probably amounts to ten thousand. And in no single instance have I seen any permanent injury follow, which could justly be attributed to the action of the quinine. Some other physicians, as for instance, Jürgensen, have even exceeded the dose of forty-five grs., which has hitherto been my maximum, without observing any bad effects. Of course the use of quinine in large doses, like the use of every other powerful agent, demands care and circumspection. The surgeon's knife, in the hand of a bungler, may work boundless mischief. If one is not sufficiently

[1] Compare *H. Thau*, Ueber den zeitlichen Werth der Ausscheidungsgrösse des Chinin bei Gesunden und fieberhaften Kranken. Ibid. Bd. V. 1869. S. 505 ff.

familiar with the individuality of the patient and the disease, and if there is no immediate danger impending, it is well to begin with a small dose, say twenty grains; if this proves insufficient it must be increased next time.

Quinine has often been declared to be ineffective, because the temperature of the patient, although reduced for a while, soon rises nearly to its former height. Such an objection is appropriate only for him who either expects a specific effect from the drug or supposes it can work miracles. Here, as elsewhere, we have to make the best of the actual working of means; theoretical delusions and fond hopes will not help our patients.

The well-known fact that a high fever, which presents complete periodical intermissions, is less dangerous than a milder fever which is continuous, or shows only slight remissions, must lead us, in the use of antipyretic remedies, also to strive for the production of as complete an intermission as possible. I do not consider the effect of a dose of quinine as entirely satisfactory, unless it reduces the temperature to nearly the normal standard, that is, to 100.5° in the rectum. If this is not done by the first dose, I increase the next one. If, on the contrary, the first dose reduces the warmth to 98.5°, or below, a not very uncommon occurrence, then the next dose is diminished. This is the simplest way to individualize, and to fit the size of the dose to the case in hand. It must also be remembered that the same dose will effect a greater fall of temperature later in the disease than it will in the second week.

Such a complete intermission will be brought about most readily if the dose of quinine is given at nightfall, so that the morning remission of fever and the effect of the quinine will come together. It is also better for the patient than if the dose were given in the morning, as, in the latter case, it might modify the evening exacerbation of fever, but could not bring about a complete intermission.

During that period of the disease when the fever already spontaneously manifests a tendency to strong remissions, or even to complete intermissions, quinine is much less indicated than during the continuous or sub-continuous stage. Its favorable effect depends chiefly on its power to produce a temporary intermission of fever; where such already exists, this precise indication is no longer present. And the power of the drug to control passing exacerbations of fever is much less certain.

A great advantage belonging to the use of quinine is that it obviates the necessity for the so frequent use of cold baths; and with patients who object strongly to the baths, it is worth a great deal to be able to omit them for a whole day sometimes, and to discontinue them altogether at an earlier period. If, on account of intestinal hemorrhage, or for any other reason, baths have to be stopped, we can usually continue the quinine. In hemorrhage from the bowels I am in the habit of giving quinine in solution with tincture of opium. Finally, quinine is sometimes very manifestly the means of saving life, in patients who already have a high degree of cardiac weakness, and in whom the baths are therefore either contraindicated or are no longer effective. I have repeatedly seen patients recover, as the result of a quinine remission, the frequency of whose pulse was already excessive and the surface of the body cool. The subsequent course of the disease in some of these showed that the fever was not particularly obstinate, and that life was thus desperately endangered only because nothing had been done to combat the fever.

The fact is, that, notwithstanding the high estimate that I place upon the cold-water treatment, and my positive conviction that it would be wrong to treat a severe case of typhoid fever without the systematic abstraction of heat (unless there were complications present that forbade it); yet if I were forced to the unpleasant alternative of adopting only one or the other of these two means—cold water or quinine—I should, in the majority of cases, choose the latter.

The great repugnance of some patients to this drug, and the fact that its administration by the mouth is sometimes followed by vomiting, makes some other method of applying the remedy, at times, desirable. Experiments with the hypodermic injection of quinine have proved that the small doses, which alone can be administered that way, produce but a very slight effect. The best substitute for the ordinary method is to give quinine injections into the rectum, with the addition of a little tincture of opium. Given in this way, the drug exerts its influence almost as promptly as when taken into the stomach.

Quinine produces equally as good results *in children* as in adults. In order to secure satisfactory antipyretic results, it is

necessary, according to Hagenbach,[1] to administer large doses, as follows: For children under two years old, 10 to 15 grains; for those between the ages of three and five, 15 grains; for those between six and ten years of age, 15 to 23 grains; and for those between eleven and fifteen years of age, 23 to 31 grains. Under the use of smaller doses the effects are often unnoticeable or doubtful, and Hagenbach, as the result of his experience, is inclined rather to increase that to diminish the doses.

In the vast majority of cases the antipyretic effect desired can be fully attained by the use of cold baths and quinine in suitable doses. But there is now and then an instance—and these seem to occur oftener at Basle than in most other places—in which the fever is of such obstinacy that additional antipyretic medication has to be employed.

The use of *digitalis* was first especially advocated by Wunderlich[2] and afterwards adopted by Thomas, Ferber, and others. When employing it for its antipyretic effect I always use it in substance, that is, in powder or in pills, as this form is far more reliable than an infusion. The entire dose is much smaller when given in substance than when the less effective infusion is used. I usually give from 11 to 22 grains, extended over a period of about thirty-six hours. In particularly severe and obstinate cases, where a sufficient lowering of temperature cannot be attained by quinine alone, this can usually be accomplished by the combined use of quinine and digitalis. The above-named dose of digitalis should be given gradually during twenty-four or thirty-six hours, and should be followed by a full dose (30 to 45 grains) of quinine. If one has succeeded in producing a complete intermission, in this way, it will probably be practicable to accomplish the same end again by means of quinine alone.

Digitalis is only to be used in those cases of typhoid fever in which there is no considerable degree of cardiac weakness, where the pulse is not yet extremely frequent, or, at least, is still pretty strong. The rule for its application is just the opposite to what

[1] Ueber die Anwendung des Chinin in den fieberhaften Krankheiten des kindlichen Alters. Jahrbüch f. Kinderheilkunde. N. F. V. S. 181 ff.—Vgl. *G. Mayer*, l. c.

[2] Ueber den Nutzen der Digitalisanwendung beim enterischen Typhus. Archiv der Heilkunde. 1862. S. 97 ff.

it is in diseases of the heart; now the more frequent the pulse the less is digitalis indicated. The impending paralysis of the heart is not prevented by the use of this drug, but seems rather to be favored thereby. No special harm is done, in patients with powerful action of the heart, if the administration of a large dose causes nausea and vomiting; of course the medicine must then be stopped.

Veratria, in comparatively large doses, has been used for its antipyretic effect, particularly by W. Vogt (l. c.). A complete intermission can often be brought about by this means when it fails to be done by quinine. I usually cause a pill containing one-twelfth grain of veratria to be taken every two hours until decided nausea or vomiting ensues. Four to six such pills are usually enough. The degree of collapse which readily follows vomiting, and the rapid fall of temperature combined, is not dangerous, and can generally soon be overcome by means of wine or other restoratives.

No further treatment, aside from the dietetic regulations yet to be mentioned, will be required in cases of typhoid fever that take a regular course, and in which no special accidents, complications, or sequelæ occur. The easiest way to sum up the whole, briefly, will perhaps be to give a sketch of the treatment that has gradually, in course of time, developed itself and become established in the hospital at Basle, and which is now also in use at the Tübingen clinic.

If the patient is admitted before the ninth day of the disease, he is first given calomel, usually two to four doses, of 8 grains each, in the course of a few hours, to which, very often, one or two doses are added the next day. From the time of his admission, his temperature is taken every two or three hours by day, and in somewhat severe cases, by night too; and whenever the temperature in the axilla reaches or exceeds 102°, or that in the rectum 103°, a bath of 68° in temperature and of ten minutes in duration, is given. Patients who require six or more baths during twenty-four hours, generally receive on the second evening, 22 to 37 grains of quinine, the measurements of temperature, and the baths, as often as required, being still continued. If towards morning the temperature falls to 100.5° in the rectum,

and if this remission is such that no baths are needed for twelve hours or longer, then forty-eight hours after the first dose a second one of the same size, or perhaps a smaller one, is given; if, however, the fall of temperature was not sufficient, then the second dose is made larger, reaching 45 grains. If this prove sufficient, then the same dose, or a smaller one, is repeated every second night as long as the continuance of the fever seems to demand it. In the very severe cases, in which even 45 grains of quinine seems insufficient, recourse is had to digitalis as soon as the morning after the administration of quinine. During the course of the next thirty-six hours, from 11 to 22 grains of powdered digitalis is used gradually, due regard being had to the state of the pulse and temperature. Immediately thereupon, that is, forty-eight hours after the last dose of quinine, 37 to 45 grains of the latter are given again. By the following morning the temperature has almost always fallen to 100.5°, sometimes to 98.5°, or even below, and frequently the virulence of the fever is broken for the rest of the attack, at least in so far as that it can be controlled by a continuation of baths and the use of quinine every other day. Under some circumstances it may be well to repeat the digitalis and quinine. If it should happen, as it very rarely does, that no sufficient remission is secured by the use of digitalis and quinine, we may still have recourse to veratria, which sometimes succeeds in sufficiently controlling the subsequent course of the fever.

It has already been stated that wherever the antipyretic treatment of typhoid fever has been carried out with proper system, it has yielded most uncommonly good results. This is made evident even by the mere statistics of mortality.

In the hospital at Kiel, during the years from 1850 to 1861, under varying and not very energetic treatment, there were 51 deaths among 330 typhoid-fever patients, that is, $15\frac{4}{10}$ per cent. During the years from 1863 to 1866, under systematic cold-water treatment, there were 5 deaths among 160 such patients, that is, $3\frac{1}{10}$ per cent., and in still later times the results seem to be even more favorable than before.

The treatment of this disease in the hospital at Basle, until the year 1865, was of the ordinary expectant, symptomatic kind,

although during the latter part of the time an occasional cold or lukewarm bath was given. Since 1865 baths have been used regularly, although for a time they were not given oftener than once or twice a day. In addition to this, quinine and digitalis were used for their antipyretic effect, though not as energetically nor in accordance with as fixed indications as they have been more recently. Since September of 1866, when I read the convincing report of Jürgensen with regard to the results attained at Kiel,

I. Under indifferent treatment :

Years.	Typhoid-fever Patients admitted.	Died.	Rate of Mortality.
1843 to 1853	444	135	30.4 per cent.
1854 to 1859	643	172	26.7 "
1860 to 1864	631	162	25.7 "
Total,	1,718	469	27.3 per cent.

II. Under incomplete antipyretic treatment :

Years.	Typhoid-fever Patients admitted.	Died.	Rate of Mortality.
Beginning of 1865 to Sept., 1866.	982	159	16.2 per cent.

III. Under systematic treatment :

Years.	Typhoid-fever Patients admitted.	Died.	Rate of Mortality.
Sept., 1866, to close of 1867	339	33	9.7 per cent.
1868	181	11	6.1 "
1869	186	10	5.4 "
1870	139	10	7.2 "
1871	123	15	12.2 "
1872	153	13	8.5 "
Total,	1,121	92	8.2 per cent.

baths have been administered with increasing frequency and of lower temperature, and antipyretic medication has been pushed farther, until, since the year 1868, the method of treatment has become pretty well established and tolerably uniform.

The result, as shown by the records of the different periods alluded to, is tabulated on the preceding page.

A mortality of 27 per cent. under indifferent, expectant, or symptomatic treatment, and of 16 per cent. under incomplete antipyretic treatment, stands opposed to a mortality of 8 per cent. under systematic antipyretic treatment. The comparatively high mortality of the year 1871 depends upon the fact, that the most severe cases of typhoid fever in that part of Bourbaki's army that had passed over into Switzerland and was quartered at Basle, were sent to the hospital. Some of these were admitted nearly moribund, and a good many died within a few days after entering hospital; although in those cases where there was an opportunity to subject them to the proper treatment, the type of fever was not found to be especially malignant.

The figures used in the above statistics are not all of them directly comparable, for the reason that before the year 1865 the term "typhoid fever" was somewhat restricted in its application, and some of the lighter cases were not classified as such at all. The limits of the error that thus crept in have, however, been defined, and, as I previously showed in another place,[1] it is proved not to make any material difference in the result. The figures in the two latter tables, however, are strictly comparable, inasmuch as the classification of cases has been uniform and rigid since 1865; and it appears, therefore, that by means of the more thorough and systematic use of the antipyretic treatment, the mortality has been reduced from 16 to 8 per cent. In order, however, to make a just comparison between those treated indifferently and those treated antipyretically, all that is necessary is to subtract from the latter list all the light cases. We should then have remaining 850 to 900 cases, with 92 deaths, or a mortality of 10 or 11 per cent. against a mortality of 25 to 30 per cent. Accordingly, not half the number of deaths have occurred among the typhoid patients

[1] Deutsches Archiv für klin. Medicin. Bd. IV. 1868. S. 415.

admitted within the past six years that would have occurred under the indifferent treatment. A careful examination would show that, in making up these statistics, those cases treated antipyretically have been most rigidly if not unjustly dealt with, so that, in reality, the same number of similar cases, treated by the two methods, would yield but about one-third of the deaths under antipyretic treatment, as compared with what we call indifferent treatment.

But the results of the antipyretic method are even more favorable than these figures would indicate. The deaths which have occurred under this method are, to a great degree, among those for whom no treatment could have done anything. Some of them were brought into hospital in desperate condition, some were very old people, and a particularly large number of them did not actually die of typhoid fever, but either of some other pre-existing disease, or of some complication or sequel only indirectly dependent on the typhoid. It is true that in former times and under indifferent treatment similar instances also occurred (though they were not then as uniformly classed with the deaths from typhoid fever); but if they could be eliminated from both sides of the account, the remaining mortality, under the antipyretic plan, would be but a small fraction of what it would be under the other. When mortuary statistics are to be taken as evidence in favor of the advantages of a certain line of treatment, then it is certainly right that all such cases should be included in the list, and that the report should err rather on the side of being too rigid than too lax. But where the main evidence is already established, and it is only a question of the closer comparison of results, then these modifying circumstances should be considered.

The entire appearance and bearing of patients under the antipyretic treatment is such that the old picture of a typhoid-fever patient is no longer to be seen. The attendants do their part gladly, although the taking of temperature and giving of baths adds immensely to their labor, because the good results are so manifest, and also because many of the annoyances of former times are for the most part done away with, such as the involuntary evacuations on the part of the patient, violent delirium, bed-sores, etc. Finally, the physician takes a very different

degree of comfort and pleasure in his calling, and feels much more certain of his results. In fact, typhoid fever has lost a great part of its terrors.

Treatment of Incidents, Complications, and Sequelæ.

Even in cases that run their course without any true complications, circumstances may arise that bring danger to the patient. Among these incidents, as we shall call them, the gravest and the most frequent is *weakness or paralysis of the heart.* Attention has already been called to the great importance of directing our therapeutic measures to the prevention of any considerable degree of cardiac weakness. When this condition has, nevertheless, supervened, to a serious degree, either in patients whom we had not previously treated, or in spite of our treatment, the hope of a favorable result is indeed greatly diminished, though not entirely lost.

The first and most important indication is to reduce the temperature as soon as possible, if it is still too high. As has already been stated, this can often be satisfactorily done by appropriate doses of quinine, especially in those patients who have not been under treatment before; while digitalis, which, on general principles, would appear to be particularly applicable to such cases, usually effects no good, and is liable to do great injury. Sometimes the application of an ice-bag to the region of the heart is of benefit. The second indication is to stimulate the heart's action through more direct means. First among these stand alcoholic drinks. I long since convinced myself by direct experiment that alcohol, even in comparatively large doses, does not elevate the temperature in the interior of the body, in either well or sick people. Since the investigations of Binz, which have been confirmed by most other observers, the widespread fear, amongst physicians, that the use of alcoholic stimulants would increase fever, has to a considerable degree subsided. I permit every patient who has been in the habit of partaking of spirituous drink freely, to imbibe moderate quantities of the same during the entire course of his illness, even giving them weaker or stronger wines, or brandy, according to their previous custom. Even patients

who have not been previously accustomed to drink, are given wine after, and sometimes also before, a bath. If a considerable degree of cardiac weakness appears, we give spirituous stimulants to all patients, those who have been taking them before being given a much larger amount, or being changed from a weaker to a stronger liquor. This stimulation must, it is true, be applied with a certain reserve, so that if the condition of cardiac weakness should be prolonged, it may be possible to carry the stimulation still further. This caution is perhaps more necessary in typhoid fever than, for instance, in pneumonia, for the treatment of which Jürgensen has again recommended the use of alcoholics in large doses, because in the former disease we must be prepared generally for a longer duration of the fever. Mulled wine, strong grog, hot punch, and also strong tea and coffee will produce a powerful temporary effect, and in case of sudden collapse these means may be of great value. About the only other restoratives that I use are camphor and musk; and I believe the camphor to be more indicated when one requires a stimulating effect for a longer time, and the musk for the purpose of combating a sudden danger from weakness of the heart.

Paralysis of the brain can be much more certainly prevented by the antipyretic treatment than paralysis of the heart, and, so far as it does not involve gross anatomical lesions of the brain, it figures but rarely as an immediate cause of death. The local application of an ice-bag to the head may contribute materially towards maintaining the functions of the brain in a normal condition. Formerly, when patients were in a state of coma, and paralysis of the brain was threatened, I used to apply the cold douche to the head, and often with the most striking results; if the brain symptoms were especially severe, vesication was employed at the back of the neck. Of late years, since the adoption of thorough antipyretic treatment, the above conditions have only occasionally been met with in patients who came under our care quite late, and even then the usual cold-water treatment, with the addition of an ice-bag to the head, has ordinarily proved sufficient to avert the danger.

When extreme excitability, and especially prolonged sleeplessness exist, the use of morphine is indicated.

Diarrhœa, as long as it is but moderate, requires no treatment. If it becomes more severe, amounting for some time to more than four copious watery passages a day, it is well to administer opium in small and repeated doses, sometimes in combination with ipecac or nux vomica, and at other times with tannin, alum, or other astringents. Occasionally prolonged constipation may call for the use of calomel or castor-oil.

In case of great *meteorism*, which is much more rare under antipyretic than under indifferent treatment, cold compresses should be applied over the abdomen, which must be allowed to grow warm there, and only be changed every half hour; furthermore, we may use cold injections into the rectum; repeated simple rubbing of the abdomen, or rubbing with turpentine; injections, with the addition of turpentine; and finally, careful introduction of an intestinal tube or of an œsophageal sound may be practised.

Dryness of the tongue and the formation of sordes about the mouth are most certainly guarded against by the use of the antipyretic treatment, and further, by allowing the patient to drink water frequently, or to hold pieces of ice in his mouth. Besides this, frequent rinsing out of the mouth is to be recommended, sometimes with red wine, or with soda-water, or with a solution of chloride of lime.

It is important to pay proper attention to the condition of the bladder. In severe cases the hypogastrium should be percussed frequently, and the catheter be used whenever required.

Actual complications and sequelæ of the disease must be treated according to the indications of the condition forming them. Only a few additional remarks will here be offered with regard to those that are most characteristic of typhoid fever.

The most important indication, in case of intestinal hemorrhage, is to limit the movement of the bowels, as far as possible, and therefore the main remedy employed is opium in small doses, so that about two grains are given during the twenty-four hours. Besides this, perfect quiet is enjoined, and the abdomen is kept constantly covered with an ice-bag. I do not believe any benefit can be expected from the much-vaunted liquor ferri chloridi, notwithstanding its unrivalled value as a local styptic, merely

because it cannot be applied to the seat of hemorrhage in a sufficiently concentrated form. I do, however, frequently combine tannin or alum with the opium, which is given in mixture. Injections, and especially cold-water injections, certainly do more harm than good, unless by a rare chance the hemorrhage comes from the lower portion of the large intestine, inasmuch as they cause powerful vermicular motion and do not reach the bleeding surface where their local action might be beneficial.

When perforation of the intestine takes place, the only hope of a favorable issue lies in securing complete absence of intestinal motion for a considerable length of time. Opium is to be administered continuously, in doses of one-third to one-half grain, at first every half-hour, afterwards every two or three hours; absolute quiet must be observed, no nourishment of any kind given, and thirst allayed only by means of ice. In case of peritonitis, without perforation, the persistent use of opium is also the best method. For a long time afterwards the amount of nourishment given must be kept down to the minimum, only the most easily digested articles being used, and those in fluid form. The physician must never allow himself to be persuaded by his patient into the giving of a cathartic or an enema, though the patient will feel as though his bowels *must* be evacuated. This will take care of itself, and a stool follow in course of time, even under the continued use of opium, and no harm will be done if a week, or even two or three weeks, pass without any movement of the bowels. Not until later, when all evidences of peritonitis have disappeared, will it be permissible to use a small, lukewarm enema, for the purpose of emptying the rectum of the hard fæcal matters it often contains.

The surest way to guard against hypostatic congestion is to maintain, as far as possible, the normal strength of the heart's action. Aside from this, it is well to instruct the patient to alternate his position from back to sides, a thing which those treated antipyretically are usually able to do without difficulty, and furthermore, to incite him, from time to time, to take repeated deep inspirations.

The severer forms of bed-sores are among the most intractable ills that we have to combat. Fortunately these severer forms

very rarely occur under antipyretic treatment; if bed-sores appear at all, they are commonly superficial, or, if deeper, are limited to small spots. One of the principal means of preventing their occurrence, aside from measures to reduce the high temperature which favors disintegration of tissue, and to maintain the heart's action, is scrupulous cleanliness—which is easily maintained where the bath is frequent—and another is care with regard to the bed. According to Ziemssen and Immermann, the use of large water-cushions is especially to be recommended, both to prevent the formation of sores and to facilitate the healing of those that exist. As long as no erosions are found, the skin, at the points of pressure, should be frequently bathed with alcohol or strong brandy; when erosions appear, the washing should be with diluted alcohol and with lead-water; the points attacked should be relieved of all pressure and all contact with anything, either by means of ring-shaped air cushions, or properly arranged folds of wadding; finally, it should be seen to that the patient lies in some different position from what he formerly did, as much of the time as is practicable. In case of sores that penetrate more deeply, the use of the unguentum plumbi tannici, and frequent washings with a solution of carbolic acid, are desirable. If severer forms of gangrenous ulcerations have set in, the measures to be adopted will vary according to circumstances. In dry gangrene it is often preferable not to disturb the mummified tissues, inasmuch as they serve, for a time, as a protection to the parts lying beneath them. In moist gangrene the patient must be permanently placed in a position to leave the diseased parts free, and the separation of the slough must be encouraged by the application of poultices made fragrant by the addition of some aromatic herbs.

The worst cases are those in which, as soon as the weight of the individual is brought to bear upon a fresh spot, that also becomes gangrenous. In such, and in some other bad cases, I have used the permanent bath to good advantage, in which the patient spends from sixteen to twenty hours of the twenty-four in a warm bath, and only four to eight hours on his bed, or, sometimes, remains in the bath continuously for several days. Of late years we employ a special bath-tub for this purpose, the head of which constitutes an inclined plane. This portion of it is covered with

a thin pillow, on which the patient's back rests comfortably, while his feet press lightly against the foot of the bath-tub, or against a stool placed there. A large sponge is then placed under the lower portion of his back, and perhaps also under his thighs, and, finally, a band or girth is put under his shoulders and fastened outside, so that, even if he falls asleep, he may not sink down into the bath unduly, or get his head under water. A board may be laid across the tub in front of him to accommodate his drinking utensils, or whatever else he may want there. Accommodated in this tolerably comfortable manner, some patients have spent many weeks, usually, with occasional intermissions, eating, drinking, and sleeping in the bath as in a bed. It is often desirable to add some decoction of oak-bark to the bath-water.

DIETETIC TREATMENT.

It is often of the greatest consequence, as regards the course and result of the disease, whether the patient comes under treatment early or late. This is especially true where effective antipyretic treatment is to be applied. So, for instance, a report made at the Basle hospital, in which only severe cases were included, showed that of the patients who were admitted before the end of the fourth day, only 5 per cent. died; of those who were admitted between the fourth and eleventh days, 13 per cent. died; and of those who were admitted after the eleventh day, 28 per cent. died. The influence of early handling on the patient shows itself also very plainly, though not quite as strikingly, where the treatment is merely expectant, but where great attention is paid to the enforcement of proper dietetic measures.

The most important necessity for a typhoid-fever patient, from the very beginning of his attack, is complete bodily and mental rest. There are patients, and, unfortunately, there are also physicians, who think the best thing to do is to fight against the disease as long and vigorously as possible, and not to go to bed until one cannot keep up any longer. Observation shows that this is just the opposite of the wise course. I have seen patients who were going through a mild, perhaps a very mild, course of typhoid fever, strain every faculty of their nature to resist the

disease, even calling into play increased physical exertion for that end; and I have seen such patients sink so low as for a time to excite fear that some other more serious disorder lay behind, as pulmonary phthisis, cancer of the stomach, etc., and finally creep out through a convalescence so prolonged as to be entirely disproportionate to the gravity of the original fever. I had an especial opportunity of observing the injurious effects of physical exertion and weariness in typhoid fever in those patients who were admitted from Bourbaki's army. On admission they presented the appearance of the very worst form of fever, and a good many of them died within the first few days, while those who remained in our hands eventually proved that the disease was by no means of a virulent type. It is a fact which was confirmed by the observation of many physicians during the late war, that railroad travelling is especially prostrating in its effects on typhoid-fever patients, and for a time makes their condition decidedly worse.[1] It often happens that physicians, even those who handle their patients on the most correct principles and with the best judgment, act very unwisely when they are themselves attacked by this disease, and especially refuse, for a long time, to admit that they are sick. I have known physicians to make calls during the morning, when the evening before they had themselves seen that their own temperature was 104° in the axilla.

The patient should be confined to his bed from the very first beginning of fever, even if the attack seems to be quite light, and he must not be allowed to sit up again until the evening temperature has been perfectly normal for from three to six days. Sometimes it is necessary to wait even longer than this. It should always be remembered that getting up too soon is liable to cause a relapse, and direct observation has proved that recovery proceeds more rapidly, and the patient regains his wonted vigor sooner, if he spends the greater part of the period of convalescence in bed. It is very desirable to have two beds at one's disposal, so as to give the patient change and admit of their more thorough airing; but he must be lifted, in the hori-

[1] Compare the remarks on this subject by *Niemeyer*. Deutsches Archiv für klin. Medicin. Bd. VIII. S. 435, 443.

zontal posture, from one to the other, or, if the beds can be placed close together, may be allowed to roll or move over without rising up. On no account should he be permitted to walk from one to the other.

One bed is usually enough, during the active progress of the disease, for a patient who is taking frequent baths, as these both fulfil the requirements of cleanliness and give time for the changing and airing of sheets, etc. Evacuations of the bladder and the bowels must take place while lying down, by using a bedpan and a urinal. Many patients declare at first that they cannot evacuate the bowels without sitting up, but if it is insisted on they soon learn to do so while lying.

Finally, it is of the greatest consequence that all mental activity and excitement should be prevented, all business affairs and all annoyances should be kept away from the sick-bed. As a general rule, it is better to have but one person in the room to care for the patient, and this person should hold no conversation with him, answer his questions as briefly as possible, and at the same time care for all his wants, even those which are unexpressed, as noiselessly as possible.

The measurement, or "taking" of his temperature, is usually least troublesome to the patient if the thermometer is used in the rectum. If the rectum becomes sensitive, or if for any other reason it seems preferable, it may be transferred to the axilla. In using the thermometer in the rectum it must be remembered that a break in the column of mercury is very apt to occur; a strikingly high record, therefore, is not to be accepted unchallenged, unless one has seen the gradual and continuous rise of the mercury after introducing the thermometer, or its continuous fall after removing it.

The temperature of the sick-room should be rather below that of an ordinary living apartment,—it should never remain long below 56° nor above 64° Fahr. Care should be taken to maintain proper ventilation day and night. In hospitals it is well, as Stromeyer recommends, to have an opening in the bottom of the doors, and a number of window-panes so arranged that they can be opened. In private houses, if practicable, a window should always be kept open in the next room, even in the depth

of winter, and the door between the two rooms never be closed. Even a strong draft of air, for a time, is harmless; a patient with a high fever-temperature cannot take cold. No one but a theoretical experimenter, who has no patients to treat, would ever recommend keeping a room so cold that the patient would be chilly, with the idea of thus reducing his temperature, and thereby dispensing with other means for abstracting heat from the body.

It is a matter of the greatest consequence that patients be properly nourished. There is no doubt that the old notion of its being dangerous to feed the patient for fear of feeding the fever, was carried to an unreasonable extreme, and credit is particularly due to the English physicians for having shown the disadvantages of too great abstinence, and the necessity of giving proper nourishment, even if the patient has no desire for it. On the other hand, there is no doubt that by over-estimating the degree of consumption of tissue due to the fever, and the danger resulting therefrom, this method has also been carried to an extreme, as, for instance, when it has been attempted to feed the patients with large quantities of meat.

Water is the one nutritive substance which the patient needs most, and of which he should partake as freely as a well person. In addition to the amount of water, which, when well, we imbibe in the form of various drinks, a considerable quantity is introduced in our solid food. Even patients who seem tolerably conscious, usually fail to partake of the necessary amount of fluid, unless reminded thereof. One should, therefore, when they are not actually asleep, put the glass or the spoon to their lips every quarter or half an hour. They will often drink gladly, when they would never have asked for it, nor reached for the glass voluntarily. If they decline the proffered drink, it should not be urged, and they should never be allowed to take much at a time. The kind of beverage to be used may be left a good deal to the choice of the individual, and it is well enough to change it frequently. Simple cold water, with or without ice, seltzer, or other similar mineral waters, wine and water, lemonade, tartaric acid, or mineral acids in water, with or without sugar, thin milk of almonds, a thin decoction of parched rice (especially

where there is a good deal of diarrhœa), thin barley-water, milk and water, and a number of others may be mentioned among the articles to be used.

Coming to the consideration of those substances usually termed nutritive, we find the use of the protein compounds in any large quantity to be interdicted. Aside from the fact that, according to all that is known of their action, a diet consisting exclusively or largely of these substances would lead to increased metamorphosis of tissue, it is farther true that these articles, in the form in which they are usually prepared, prove incapable of digestion by a sick man. Fats, in any considerable quantity, are also not digested, that is, not absorbed. It is evident, therefore, that the introduction of any large amount of such food would produce or increase gastric and intestinal catarrh. We must fall back, then, upon those nutritive substances into whose composition the carbohydrates enter largely, and thus we arrive at about the same fever diet that has been advocated by experienced physicians of all times since the age of Hippocrates. The fact is, that mucilaginous barley-water, thin oatmeal gruel, and the like, combined with not very strong meat-broth, constitute about the most desirable diet. According to Stromeyer, oaten grits is the best thing to give to typhoid-fever patients; this should be cooked for three hours, and given without sugar. In addition to these things the patient may, if he likes, have milk, but only when boiled and reduced with water, seltzer-water, tea, coffee, and the like; and the further advanced the disease the oftener may the yellow of an egg be beaten up with the meat-broth or barley-water. It is often necessary to bring a good deal of persuasion to bear before the patient can be induced to take the requisite amount of nourishment. In those who are quite low it is well to use concentrated beef-tea, prepared by long boiling of the meat in a close-stoppered bottle, or Liebig's beef-tea, prepared by macerating the meat with hydrochloric acid, both of these being improved by mixing with claret wine. Such cases might also be benefited by Leube's meat-and-pancreas injections.

Wine and liquors, as was stated before, are admissible at any stage of the disease, even during the height of fever; still it is best to be governed in their use by the former habits of the

patient as well as by his present condition. Extract of meat is still ordered by some physicians early in the disease; I believe I have seen an increase of the diarrhœa caused thereby. There is no objection to using it in small quantities, as a means of flavoring the barley-water; but it is to be hoped that no physician any longer looks upon it as a nutritive substance. Solid food, especially meat and bread, should be reserved for the period of advanced convalescence, and even then the possibility of perforation of the bowels, or of a relapse, being caused by errors in diet, should always be borne in mind.

TRANSLATOR'S NOTE.—The unguentum plumbi tannici, mentioned on page 227, is made, according to the German Pharmacopœia, by mixing freshly precipitated tannate of lead with glycerite of starch.

RELAPSING FEVER,

TYPHUS FEVER, AND CHOLERA.

BY

PROFESSOR DR. LEBERT.

INTRODUCTION.

MODERN researches on the connection between infection and contagion on one hand, and the development of organisms on the other, possess a profound and increasing importance as regards general, and particularly special, pathology, in relation to the hygienic, prophylactic, and other treatment of infectious diseases. On this account I feel that I ought to begin by defining my position towards this important question in a general way, in order to come to an understanding with my readers, as well as to avoid repetition in treating of the etiology of relapsing fever, typhus fever, and cholera in the following chapters.

I can estimate, perhaps, better than many other clinicians and physicians the progress made in this direction, as I have occupied myself with these etiological questions for some years. The results of my researches in regard to diseases of blood-infection, have, until the past few years, been only negative, and I must confess that, excepting those relating to relapsing fever, they remain negative to the present day. I do this without intending to commit myself to any ultimate negative conclusion, since we know from examination of vaccine lymph and small-pox that certain peculiar vegetable parasites are found in the fluid and in the meshes of the pustules as well as in the lymphatics, while at the same time an examination of the freshly drawn blood shows no trace of their presence. The fact is, that examination of the blood alone cannot determine these questions.

My researches upon the endless number of vibriones which I found in the intestinal mucus excreted in the earlier hours of dysentery, brought me to a position in harmony with the views of animal contagion held before the time of Linnæus, and maintained by that great reformer of natural history. I guarded myself, therefore, in the observations made known in 1843 and 1845,

in my *Physiologie pathologique*, against drawing further conclusions. I was as cautious, also, in the conclusions which I drew from the remarkable observations made by myself on the hospital gangrene of scrofulous ulcers, in the Children's Hospital of Paris, and in private practice, observations made in 1846, and described in my prize essay on scrofula and tubercle. I was much astonished to find the entire tissue-detritus of these rapidly eroding ulcers composed of myriads of moving bacteria, so that their connection with the process of destruction was not to be denied. I observed a similar instance, in Paris, during 1848, in the case of a child from whom I had removed a cervical cyst. Here, the wound, which was healing, suddenly became converted into a deeply corroding ulcer, dependent upon bacteria. This ulcer took on healthy action somewhat later, and became entirely healed. Still more surprising to me was a little epidemic of the same nature, which I observed among certain frogs in the year 1851. I had severed the spinal cord in these animals, and had placed them in perfectly clean porcelain dishes, covered with damp compresses, intending to observe in them the phenomena of wounds and the formation of pus. In addition to the amœboid movement of the pus cells which I had previously observed, and which led me, at that time, to the erroneous conclusion that these were true amœbæ and caused me to figure them as such (*Anatomie pathologique*, Planches II., Fig. 15), I observed every one of the wounds made in these animals to become covered in a few days with a yellowish-gray detritus. This detritus on examination proved to consist entirely of a peculiar bacteria, large and pointed at one end. All the animals died after a few days, apparently from infection, through relatively small wounds.

My subsequent researches during the years 1856 to 1858,[1] on the disease prevalent at that time among silk-worms, led to quite different results. Here I found as the principal cause of this disease, so fatal to the silk industry, a peculiar minute fungus infiltrating every tissue of the body from the egg to the complete butterfly. This fungus, on account of its char-

[1] *Lebert:* On the Disease at Present prevailing among Silk-worms. Jahresbericht über die Wirksamkeit des Vereins zur Beförderung des Seidenbaues für die Provinz Brandenburg. Berlin, 1858.

acteristic of penetrating the entire organism, I named *panhistophyton*. Here, then, for the first time, a disease was demonstrated in which a fungus not only spread through the entire organism, constantly attacking new victims by contagion, but progressed also by hereditary transmission by means of the germ, thus again destroying the succeeding generation. I pointed out, likewise, at that time, that the blood of diseased worms, if mingled in sufficient quantity with that of healthy ones, would give rise to a series of very remarkable changes in the latter. I pointed out the increase and propagation of these fungi by segmentation, which up to the present time is the only mode of growth known, and described the numerous macroscopic tumors of the cocoons, composed entirely of minute fungi, in regard to the significance of which the descriptions accompanying the plates left no doubt. I had previously observed in Paris, with Rayer and Davaine, the constant presence of bacteria in the blood of animals suffering with diseases of the spleen.

I remain, however, quite non-committal in my general views of contagion and infection, since there are various views maintained by different parties, one of which contends for a cryptogamic origin of contagion, the other for an organic poison as the basis. From a theoretical point of view the latter seems to me very improbable, since although a poison may indeed spread quickly from the point of inoculation through the entire body, yet organic poisons are not contagious. On the other hand, however, my researches upon the blood make me more and more cautious. Even at the present time we possess a sufficient number of facts to enable us to make out some of the general laws of organisms, particularly the probability of organized germs of the lowest fungi acting as agents of infection in infectious and contagious diseases. Thus, as among the exanthemata, the pustules of vaccinia and variola have constantly been observed to contain the minute micrococcus-like round fungi (the rapid multiplication of which has been observed by my colleague, Ferdinand Cohn, and myself); so, also, we have strong support for the propagation of relapsing fever by means of the fungal mycelium discovered in this disease by Obermeier.

The fact that I have been unable, in spite of many attempts,

to cultivate the fungus of the vaccine pock, or that of relapsing fever, by artificial means, only proves that thus far I have not been in a position to successfully imitate the conditions of rapid multiplication found in the human organism. Neither the temperature (that of the body) constantly maintained in my researches, nor the utmost variety in the fluids used for the cultivation of bacteria, have sufficed. Probably the conditions of luxuriant growth are found in some peculiarity of structure in the living organism. Of similar significance is the fact that I have not, up to this time, even with the strongest and best immersion lenses, been able to find these lower fungi in the blood in cases of typhoid and typhus fever; although seven years ago, Coze and Feltz, and more recently Davaine and others, have been able to bring about an infectious and fatal disease in animals by transfusion of the blood of typhus patients. While only very small quantities of blood were used in these transfusions, the blood of the diseased animals as well as the various organs contained bacteria in immense numbers. It is possible, however, that these latter facts may allow of other interpretations.

Now it is in the highest degree improbable that, in the face of constantly accumulating observations regarding the direct influence of the lower fungi upon infection and contagion, other laws should exist, according to which both of these might take place without the intervention of organic germs. There is as little positive proof here as elsewhere of spontaneous generation. Toxicology teaches us, moreover, that there is no single poison, organic or inorganic, which while absolutely imponderable and imperceptible, may fall upon and decimate entire populations; still less does it possess a single fact to prove that the original poison may be transmitted, without direct contact, from one human being to another, and unfold itself anew in the latter in full activity. There are, it is true, certain ferment-poisons, which, like that of hydrophobia, may even in small quantities exert intense influence, and by inoculation in healthy animals give rise to similar disease. On the one hand, exact researches on these animal poisons are wanting, and as regards malignant pustule, the importance of the fungous element is plainly proved. The future must determine whether or no there exist fermentoid

infectious poisons without minute fungi. Poisons in the ordinary sense may indeed cause sickness, or even death, but are not contagious. On the other hand, the whole natural history of infectious diseases, the process of infection, contagion, etc., is in accordance with that of the lowest vegetable organisms. A positive theory of parasitic infection is, however, scarcely justifiable as yet.

Before proceeding farther I may be permitted an etymological observation. Naegeli has named these minute plants *schizomycetes* because they propagate by fission. The fact really is, that the fission is found to be simply a cross-section in the rod-like bacteria and spirilla, and I have often observed it in my ovoid *panhistophyton* of the silk-worm. On the contrary, the gemmation of the *micrococcus*, as has been observed in the *microsphere* of small-pox lymph, is rather a biscuit-like[1] contraction with subsequent separation. At times this segmentation assumes in the case of neighboring cells a quadrate sarcina-like arrangement; but the propagation of the micrococcus may nevertheless always be demonstrated as a gemmation alone, and not as a fission. Naegeli has, in addition, separated the schizomycetes from the fungi, although their entire deficiency in chlorophyll, as well as their method of development, render them much more like the single-celled fungi than the algæ. We are concerned here with the lowest vegetable forms, those which are recognized by their extreme minuteness, being in fact on the ultimate boundary of microscopic vision, and which are held by the best mycologists as incapable of becoming transformed into more highly organized fungi by cultivation. I include, therefore, the groups of globular, rod-like, and spiral fungi (it seems to me as irrational to speak of globular bacteria as of globular rods) together under the name of *protomycetes*.

Though our knowledge in this department is as yet very incomplete, still every one who is familiar with the results of the latest researches, will agree with me that a deep and intimate connection exists in a great number of cases between the development of protomycetes in the human organism and infectious

[1] Like a lady-finger.—TRANSLATOR.

diseases. I believe also that it will probably happen in this case, as in the thousand-years' conflict over the theory of spontaneous generation, that the facts against the latter, and which correspond to the protomycetic theory, will win more and more victories in the domain of research, until the term generatio spontanea will be considered as synonymous with generatio incognita. Thus possibly may the facts of the germinal origin of infectious diseases supersede the hypothesis of their primitive origin. Still we must be cautious in bringing forward prematurely an exclusive theory in order to support a theory of uniformity.

The great theoretical difficulty just now in the pathologically valuable protomycetic hypothesis begins at the moment when it is attempted to get a clear view of the method of its action. Before we approach this more nearly let us examine a few experimental facts in their bearing upon the theory. In the first place, we notice the existence of a number of infectious diseases which may make their appearance in few or many cases, without, according to our present ideas, being contagious. Salisbury's statements in regard to the influence of the minute palmella-like fungus have not thus far received scientific confirmation. For this reason the existence of malarial protomycetes can thus far only be accepted as an hypothesis, and it cannot yet be decided whether the air alone is the bearer of malarial infection, or whether, more probably, as I incline to believe, some fluid—it may be dew or mist, it may be drinking-water—is the agent. In the latter case the malarious would at times become rather a mal-aqueous infection. Here non-contagiousness alone is settled; all beyond is conjecture.

We cannot at present get a clear idea as to how the infecting, probably parasitic, element of the infectious diseases obtains entrance into the organism. The constant integrity of the organs of respiration and the constant implication of the spleen in intermittent fever would certainly seem to indicate that, whether the poison has been inhaled or ingested by means of fluids, the starting-point of the disease is in the digestive organs; but beyond this we would not draw any conclusions, since the spleen may be infected from so many quarters.

Similar relations exist in the various forms of typhus;[1] for in these also the spleen is among the organs most frequently and earliest affected. But it is especially the different forms of typhus that are characterized, as we shall learn later of small-pox among the exanthemata, by multiplicity of modes of development and ways of transmission. In relapsing fever we have at present in the spirochæta-like fungi very probably direct pathogenetic elements. In this, as in typhus fever, we observe a decided contagiousness, though not through the excretions, which neither show any peculiarity, nor, when freshly examined, contain fungi. The contagion can be transmitted through direct or indirect contact, as in sleeping in a chamber, or even in a bed in which a person having had the disease has previously slept.

Under other circumstances transmission may occur even without contact, as in the case of physicians and attendants, and also through mere contiguity, as from bed to bed in the same ward. It is probable that under these circumstances the atmosphere, particles of clothing, bedding or linen, as well as the food or drink of the patient, may act as carriers of the disease germs. Since these lowest organisms may persist at a minimum of life for long periods, it may easily be understood that particles of clothing, rags, in a word, the most various objects, may transmit (time and opportunity being afforded) the disease germs clinging to them to great distances. Thus in a given place an epidemic may break out unexpectedly, which coming from a distance, and after long quiescence of the infecting matter, cannot be explained except in the above manner.

If, now, contagion occurs between individuals, it is evident that the more thickly crowded together people live, as in the dwellings and lodging-houses of the poorer classes, in jails, etc., the more rapid and extensive such contagion will take place. But even in the case of this contagion from one person to another, which we find alike in small-pox, measles, and scarlatina, the atmosphere acts only as a carrier, and the question may well be asked, whether the germs remaining but a short period in the atmosphere may not attain fluids, and by means of these pass

[1] In the German sense of the term.—TRANSLATOR.

from one organism to another. The atmosphere would certainly seem too lifeless to afford more than the minimum of existence to the protomycetes, which indeed remain in it only during a short transition period, afterwards to unfold in the fluids of the body their full vital activity and incredible power of reproduction. Nevertheless our pathogenetic protomycetes must be very easily transmissible through the atmosphere, and withal able to effect powerful contagion. That water, particularly that which is in the ground or in the springs that are fed from it, may become the principal seat and nidus of these disease germs, follows naturally from the general law that these lowest fungi flourish and multiply best where they either find their nourishment directly in fluids, or in animal or vegetable tissues which are saturated with fluids. The old division into volatile and fixed contagia, or miasma and contagium, is only an external one, and does not at all express the essential nature of transmission in infectious diseases.

Thus we observe transmission taking place in small-pox as well by contact or inoculation as by the more indirect, distant, and more volatile methods. Inversely, however, we find that those diseases which, like typhoid fever, dysentery, and cholera, are transmitted by means of germs that emanate from the excretions, particularly those of the intestines, may again cause infection, either through the atmosphere or by means of the ground or drinking water.

Thus, for instance, upon the appearance of cholera, we observe the greater part of an entire population under the influence of the epidemic, with gastro-intestinal disturbances, etc., while a relatively much smaller number of those directly exposed to the morbid agent, through drinking-water and the like, are attacked by the cholera itself. The atmosphere in these cases must serve as a carrier of infection. Insufficient introduction and unfavorable conditions of development for the disease-germs probably account for the fact that the infection is so frequently abortive in its results.

That the protomycetes of epidemic diseases are limited to certain centres of vegetation in a manner common to all plants and animals, from highest to lowest, may be shown, as in the case

of the helminthi, by the geographical distribution of the infectious diseases. As the trichina, for instance, occurs with peculiar frequency in some regions of Central Germany, and the bothryocephalus in Western Switzerland, so we find the hotbed of cholera in India, and that of yellow fever in those portions of the Atlantic Ocean which wash the shores of Mexico and the Antilles. Thus the plague was originally an oriental disease, and the delta of the Nile spread far and wide its destructive germs, as that of the Ganges and Brahmaputra spread those of cholera. So, too, we observe certain fixed centres for typhoid and relapsing fever, as Ireland, Galicia, Upper Silesia, certain provinces of Northern Italy ; and miliary fever is a true endemic disease in a few provinces of France, Germany, and Italy.

Typhoid fever and cholera are, in relation to the protomycetic theory of infection, of great interest, as we frequently have here an opportunity to prove that one single patient, whose fluid excrements, passing from a privy into the ground, and thence into drinking-water, infect all those coming in contact with the germs thus sown and multiplied. Drinking-water is an important element in this connection, since those cities which possess a water supply free from excrementitious infiltration enjoy, as Foerster has lately shown, a certain immunity from cholera. The more such germs derived from drainage are enabled to develop in the well-water, the more predisposed is a given locality or neighborhood to infectious-contagious diseases. An accessory reason is often found in the fact that the well-water is not perfectly isolated from soil infiltration. Pettenkofer is undoubtedly correct in laying great stress upon the nature of the well-water and soil. Drinking-water, however, is the more important carrier of contagion, although the air also acts as a frequent medium. The drinking-water theory seems to me to be sustained without depending upon the well-water theory, while this gains a higher pathogenetic significance from the former.

That, however, infection and contagion are not dependent alone upon well-water or drinking-water, and their connection, however slight, with excrementitious matter, is shown by the following fact. In some old cities, as for instance Breslau, many

of the older houses have wells which stand in the closest proximity to the privies; notwithstanding which the appearance of cholera and typhus is only occasional, and restricted within relatively small limits. Putrid matters in drinking-water may indeed give rise to gastro-intestinal disturbance, but are not sufficient to bring about typhus or cholera. Should typhus or cholera germs appear in these fluids, so favorable for their growth and propagation, they may develop rapidly their destructive action, and, by becoming disseminated through the atmosphere, favor the development of these diseases.

It often happens, for example, that a large number of typhus cases make their appearance in barracks, and the cause is found to lie in the insufficient separation of the drinking-water from excrementitious infiltration; the harm was done when the emptyings of the stools of the first typhus patient found their way to the privy, and through this to the drinking-water.

So long as these facts are not understood,—and most physicians even at this day do not interpret them correctly,—the tedious and sterile controversy as to whether typhoid fever is or is not contagious must be prolonged; and indeed we often meet in the history of science similar discussions about yellow fever and the plague. I must guard myself, here, however, equally against the exaggerated notion that typhoid fever is contagious only through drinking-water. The atmosphere and various solid substances may act equally well as carriers of contagion, effecting this however less intensely and less frequently than in typhus and relapsing fever. Probably there are in these cases many unknown methods of propagation, and no single one is of exclusive importance.

The exanthematous infectious diseases are peculiarly instructive in their course. From the moment of contagion to that of the prodromes, we have the so-called stage of incubation, which may vary from one to two or more weeks. During this time the germs, which may have entered the organism, remain innocuous so long as they exist only in small numbers. Gradually, however, they become multiplied to such a decided extent that, requiring the fluids of the body and its constituents for their nourishment, they give rise to disease. The prodromes do not

point to the period of entrance of the disease germs, but to their first effects and the localities of their development in mass, which may be different in different diseases and germs; thus it is in measles the respiratory mucous membrane, in scarlatina and small-pox the mucous membrane of the digestive tract. Only later do these germs penetrate to the surface of the body and determine there the peculiar exanthematic irritation. Now the various kinds of fungi which are at the bottom of the different infectious diseases show their highest development each in its favorite locality, as the external skin in the exanthemata, the respiratory mucous membrane in influenza and whooping-cough, and the digestive tract in typhoid fever and cholera. This agrees with the natural history of plants and animals in other respects, and particularly with that of parasites. Thus the trichina lives principally in the muscles, and the tapeworm in the intestinal canal; while the ova of the latter lead their baleful lives within the parenchymatous organs.

All these observations lead us to the necessary logical conclusion that there exists for each definite disease of infectious origin a specific germ, or protomyces. From a pathological standpoint it would be absurd to suppose that the same fungus might give rise under varied conditions to measles, scarlatina, small-pox, typhus, or cholera. The previously mentioned various geographical centres of the different diseases would speak against that view. To be sure, just here a great optical difficulty is encountered. Even the present advanced perfection of our microscopes does not permit the discovery in many cases of any specific variations in appearance between protomycetes whose effects are most widely different, although the best lens—for example No. 15 Hartnack immersion—be employed. We can, indeed, not only make out the globular, the rod-like, and the spiral varieties, but also, within each of these groups, different and easily distinguished species, as Ferdinand Cohn has demonstrated in his valuable researches on bacteria,[1] illustrated by characteristic figures, the result of many accurate investigations, and which express very well the advanced position of our knowl-

[1] Beiträge zur Biologie der Pflanzen. Zweites Heft. Breslau, 1872.

edge. Nevertheless he does not overcome the difficulty of classifying physiologically and optically the different species, according to the different manifestations of disease which they produce. The results of observations made previously by Pasteur, in regard to the impossibility of distinguishing between the milk and acetic-acid ferment, as well as between ammoniacal urinary ferment and the mucilaginous ferment of wine, were to a similar effect. Schroeter and Cohn confirm the same for the pigment bacteria, which cannot be distinguished from one another microscopically as to their production of red, yellow, blue, orange, or other pigmentation. And yet each variety produces constantly and exclusively the chemical change or coloration belonging to it alone. Similarly we find in the case of the pathogenetic protomycetes that their effect in regard to the production of peculiar infectious diseases is always the same for each species: there are always distinct diseases in the case of two different varieties. And this at all times and in every country. Cohn brings forward (p. 135) the ingenious hypothesis that the result may take place in these cases in a similar manner to that observed in plants, which constantly differ in their products according to the circumstances of their cultivation; as for example, almond trees, one of which may bear poisonous and bitter fruit while another bears sweet. As in the protomycetes, propagation takes place by gemmation and not by fructification, so also in the cultivated varieties propagation, as a rule, does not take place by seeds, but, on the contrary, by unsexual means, through budding. So far as vegetable infection-germs are concerned I cannot accede to this view. The cholera originating in India, the oriental plague, the yellow fever arising on the borders of the Gulf of Mexico, all retain their original type as exact and invariable as in their mother-country. The smallpox is the same disease in South America as in Northern Russia; scarlatina the same in Mexico as in Scandinavian countries. Although appearances here may easily deceive, transitions from one disease to another, or instances of hybridity of disease, are never observed. We often see in Breslau, as in London, both typhoid and typhus fever, and yet I have never, in fourteen years, observed a single case which could be proved to be ana-

tomically and clinically intermediate. The same holds good of the otherwise so nearly related diseases, typhus and relapsing fever. Of greater importance still is the fact that a person who has once suffered from an infectious disease is protected for his whole life, or at least for a long space of time, against a similar attack, even although the disease may be very prevalent around him. Moreover, no one of these diseases gives protection against another; thus typhoid fever does not protect from typhus; indeed, in the case of relapsing fever and typhus it would seem as if an attack of one predisposes the individual to an attack of the other.

The action of the protomycetes cannot be predicted from their optical qualities. It is true that in diphtheritis, vaccinia, small-pox, septicæmia, pyæmia, mycosis intestinalis, and in lymph thrombi of puerperal infectious diseases, the globular form of the protomycetes prevails. The fact that Davaine has already demonstrated the constant presence of rod-bacteria in malignant pustule (and this might be one reason more for giving up the improbable connection between mycosis intestinalis and malignant pustule), and that the spirochæta-like filaments of Obermeier are found in relapsing fever, prove that the spiral protomycetes may take part in infection as well as the globular, rod-like, or ovoid (as in my panhistophyton of the silk-worm).

Perhaps at a future day, when some principle of classification has been discovered, we may have to go much farther in division of species than at present seems possible. Cohn declares the fungus of vaccinia, described by him previously, to be identical with that of the small-pox itself, as described by my assistant, Carl Weigert, from reliable preparations. The optical identity of both I admit, as well as their identity with the micrococci discovered by me in the fluid of fresh small-pox pustules. But, then, I come upon a pathological difficulty in relation to the question of identity. If we inoculate by means of the fluid of the cow-pox,—that is, with its fungus, the microsphæra vaccinæ, we always obtain pustules on the spot of inoculation alone; or, at most, a few in the neighborhood, but never a considerable eruption. The result is quite otherwise in the case of true human small-pox, in regard to which we possess

the most exact details from the last century. If the fluid from a pustule of the mild form of variola be inoculated, a genuine variola, running a mild course, develops itself throughout the entire body.

The effect of the protomycetes of vaccinia is thus entirely different from that of variola, although nevertheless the former protects against the latter. With such different effects, is it probable that the protomycetes are the same in both cases? For myself, I am inclined to believe that they are not the same.

In his truly pioneer work on the bacteria, Ferdinand Cohn fully expresses his views in regard to the difference between the bacteria which give rise to putridity and those which cause disease—between saprogenetic and pathogenetic bacteria. If the great department of bacteria be included entire, then such a distinction may be justified; pathology, however, cannot regard it as admissible in all cases.

The doctrine of septicopyæmia as a protomycetic disease, so greatly advanced by Klebs, shows already the inadmissibility of this distinction. Have we not then a saprogenetic effect when septicæmia results from an ichorous wound, or from the ichorous granulating surface of the pleura following a wound of the chest? What becomes of the distinction between saprogenetic and pathogenetic effects in this case?

How greatly, in all these questions, our knowledge is confined to the effects visible on the surface only; and how little we understand of the deeply operating causes of the infection process, is shown by our helplessness when we attempt to solve the question of how the infectious elements were brought in contact with us. That this is accomplished by means of the water chiefly, next by aid of the atmosphere, and finally by the clinging of the germs to living or lifeless objects, is a logical postulate; but, even here, sufficient, exact, and directly proving facts are wanting. Still more difficult is it to answer the question, In what manner do these germs enter the body? In the diseases of caterpillars it has been proved, so far as muscardine and the new disease discovered by Cohn are concerned, that the germs penetrate through the skin, and thence spread throughout the interior of the body. The case is probably similar with the fungus disease of the fly.

All these fungi, however, are quite different in their nature and effects from the protomycetes. On the other hand, I have not been able to make out how the panhistophyton, which I have studied so long and so carefully, and which belongs to the group of bacteria, penetrates the body of the silk insect. Its entrance into the egg points to heredity as a new source; but, on the other hand, I have been unable, by merely causing healthy worms to live together with the diseased, to communicate the affection, while I have constantly succeeded in communicating muscardine in this way.

In man most fungi of the skin and mucous membrane either cause disease of the surface alone or remain without any pernicious effect, as in the case of bacteria of the entire digestive tract and leptothrix buccalis. But is this always the case? I doubt it. The transmission of malignant pustule by the agency of flies—in which sense alone the poisonous character of Livingstone's African poison-fly is to be received—constitutes really a deeper inoculation; on the other hand, it would appear that glanders, implanted on the surface of the human body by the mere snorting of horses having the disease, is capable of penetrating to the inner parts. In diphtheritis I still remain undecided as to whether the fungus of the pharynx is the primitive, or, as Oertel and other very competent observers affirm, the secondary localization of the disease. Perhaps both views may be correct; at all events I have noticed, by daily examination of all the members of a family, in which one child had died of diphtheritis, that sometimes one or two, who were suffering from no other disease, would manifest undeniable signs of diphtheritis of the throat, which would yield, however, to thorough cauterization with nitrate of silver. Not so easy to interpret are those not unusual cases in which the diphtheritis of the throat runs its course as an absolutely innocuous local process, without affecting the organism generally. The conjecture is justifiable under these circumstances that the disease has only become developed locally from the contagion, and has not permeated the entire organism.

The respiratory and digestive mucous membranes are most frequently the ways of entrance for the infecting germs. Locali-

zation alone may very possibly be connected with this; but it does not seem necessarily the case, since usually at the outbreak of the prodromata the entire period of incubation has expired without any signs of localization. For example, by the time that the prodromata of measles begin with sneezing and coughing, those of scarlatina with sore throat, or those of small-pox with pain in the loins and sick stomach, the germs have already been multiplying in a latent manner at least one or two weeks before these prodromal localizations take place. Even the initial erythematoid exanthem of small-pox is far less extensive than the now hardly apparent numerous characteristic pustules. I would not, therefore, like to decide whether, in influenza and whooping-cough, the parasitic germs develop their effect from the very beginning, in the respiratory tract, or only become localized there at a later period. Both possibilities are admissible; and if, in the case of the exanthemata, the skin affection is most probably a secondary manifestation, it can easily be seen that in the case of the whooping-cough it may occur otherwise. Very probably, however—and this follows from the resulting effects and conditions—the germs of certain different infectious diseases have a peculiar tendency toward and predilection for those parts of the body which they find most suitable for their nourishment and development; the localities varying with the different species of protomycetes. Thus in similar localizations the anatomical intensity may stand in relation to the development. For instance, the superficially spotted, irritable condition of the skin in measles, the diffuse erythematous red of scarlatina, the formation of very numerous miliary abscesses of the skin in small-pox, may be explained in this way.

It is probable that the original point of entrance of the infectious germs is to be found more frequently in the digestive than in the respiratory organs, since, as is known, all protomycetes find their chief source of increase in water, while the atmosphere generally serves merely as a carrier. For the diseases which infect drinking-water particularly, this is in the highest degree probable, as well as for those which are directly contagious, such as the acute exanthemata, typhus and relapsing fever. It seems probable, therefore, according to the natural history and

laws of development of the protomycetes, that they also find their principal nidus in water. It is only thus that we can explain the various geographical centres of certain infectious diseases, and the frequent sporadic appearance in these of a disease which is only occasionally epidemic. The fact that even in their original locality certain infectious germs develop to an important degree only exceptionally and at long intervals, finds confirmation in the general natural history of plants and animals.

If we find a rare insect appearing in great frequency, or a usually inoffensive one giving rise on a sudden to great destruction; if we see a usually harmless fungus destroy all at once both seeds and harvest; then we find, also, by closer examination, that the germs of these species have been exposed to noxious and inimical influences by their early surroundings, and that, to use Darwin's expression, they have been barely able to prolong their existence. But at long intervals they find the circumstances of luxurious development occurring, and become, instead of harmless species, destructively noxious, even calamitous ones. I observed some time ago, in the Cantons of Vaud and Valais, a grasshopper plague, and carefully investigated at that time the habits of the migratory grasshopper; I found that in the localities devastated they had usually existed only in small numbers (at least such was the case in the Valais); that, moreover, these insects laid their long and large eggs in such exposed places that the preservation of the species was greatly to be wondered at. If, however, very favorable conditions of development should arise, the increase of these grasshoppers might be so great as to bring about a plague. That there had been great variations in this respect at different times, and that advances in cultivation tended to restrain within bounds the luxurious and noxious development of these insects, was shown by the fact that some centuries ago, in Sion, the chief town of the Valais, a "grasshopper mass" used to be solemnly held each year on the first of May, from which the much greater frequency of this plague in old times might be inferred. If it has been established on the part of the naturalists that water serves peculiarly well for the nourishment of mycetes, it has equally been shown, on the other hand, by pathology, that the atmosphere and fixed

objects may undeniably spread far and wide the germs of many diseases, without their capability of development having suffered. Interpretation of facts by a favorite analogy is to be guarded against. As the naturalist has here aided the physician, so may the physician, on his side, add to the results of the naturalist and amplify his range of view.

The history of bacteria, and particularly the results of experiments in cultivation, show us how sometimes, when one species is grafted upon another, that one which at first possessed but little vitality gradually succeeds in utterly destroying the other, which at first was the more thriving of the two. Thus the germs of an epidemic infecting disease may easily become displaced by a harmless species, and by means of the latter a limit may be fixed to the epidemic devastation. In this connection the fatal disease of the silk insects is very instructive. When Bassi and Audouin observed the muscardine in 1830, there was a very wide-spread disease of the silkworm, particularly in Lombardy. Already in 1855 it was less frequent, though I could still obtain at that time sufficient material for my studies and experiments, while now it has become very difficult to do so. About this time a new disease appeared, which I described as *dystrophia mycetica*, and the principal element of which I have termed the panhistophyton ovatum. This disease soon spread not only over Italy and France, but also through Switzerland, the Brandenburg Mark, and Silesia; destroying in many places the flourishing silk culture. After lasting about ten years this also disappeared, and a new disease, dependent upon the development of globular protomycetes, came in its place, and even at the present time effects quite an extensive destruction.

If the germs of various infectious diseases become developed independently of one another, we observe several epidemics at the same time. If, then, the mycetic germ of a pestilence is supplanted, not by one in no way related to it, but by a pathogenetic protomyces, it would seem as if two epidemics, so to speak, were fighting until one should be conquered by the other. Relapsing fever and typhus fever manifest such relations in Ireland, and indeed to a less degree in Breslau and Posen.

If we already find ourselves in all parts of this department upon strange ground, with but a relatively small number of positive facts at our disposal, and are obliged to draw conclusions at best only probable in their nature, we shall find ourselves in a still more obscure department if we desire to establish the manner in which the protomycetes cause infection. The rapid and enormous multiplication of germs, with which we are familiar in vaccinia and small-pox, in septicæmia and malignant pustule, in diphtheria, and, recently, in relapsing fever, naturally lead to the conclusion that the nourishment of these parasites affords the principal reason for the blood changes in the body and the consequent sickness. It may be concluded also that the protomycetes for the most part need for their luxuriant growth the nitrogen, the carbon, and the various acids and salts of the more highly organized animal body. The products of the metamorphosis thus brought about—as we learn by a chemical analysis of the infected organisms—viz., the increased excretion of urea and uric acid, the formation of leucin, tyrosin, xanthin, hypoxanthin, kreatin, inosite, etc., which we find in the various organs in cases where death has occurred from some infectious disease, do not differ from those found in other affections, and consequently are not to be considered as the peculiar effects of the protomycetes. As regards the chemical action of the germs, we have only hypotheses. We may consider the process one chiefly of oxidation or reduction, or we may explain the whole series of actions as a fermentation. That, however, would be explaining a very obscure idea by one no less obscure. In the same way it is a possibility—which however explains nothing—that from the protomycetes, which may indeed cause the appearance of false membranes and various pigments, a pathogenetic material may also be developed.

We must therefore hold only to the fact, that besides the local effects which they may produce, the parasites, in all diseases in which they are found, excite a high fever. What the chemical nature of these pyrogenetic processes may be, we have never learned in a satisfactory manner, not even through Billroth's excellent researches upon traumatic fever. We may conclude, however, from the effects, that the protomycetes, among

other changes which they produce in the processes of metamorphosis of tissue, call into existence certain noxious or even poisonous elements which may lend to the disease a malignant character from the beginning, and even cause it to end fatally. With great propriety Klebs and Oertel remark upon the disturbance of circulation, which may be brought about by masses of protomycetes, and the thrombi and emboli to which these may give rise. Other evil results are exhaustion by loss of fluids, and thickening of the blood by deprivation of its watery parts, as in cholera. In this whole department we understand very imperfectly even the effects, and are forced to deduce the actual processes by logical reasoning; and then, as to the positive facts, of which very few are available, we are in a position to judge at best only imperfectly.

It is also very probable that through the fever and its products the protomycetes become so restricted in what they require for their existence that their evil effect upon the patient ceases; but still a sufficient number of them must survive and pass out from the system, after which, under favorable circumstances, they keep up a minimum degree of vitality and serve as seed for new harvests of disease. If this detrimental influence of the fever upon the parasite should be a very quick one, then correspondingly quick will be the fall of temperature, or the crisis, which, however, may prove only temporary, as in relapsing and intermittent fevers; or the fall may be gradual, as in typhoid fever; or there may be pure serous discharges to such an extent as to thicken the serum of the blood and the nourishing fluids. Thus the development of the parasite will be limited, as in the case of Asiatic cholera, while the germs removed in the discharges may give rise to similar disease in other individuals. It is highly curious and inexplicable, as yet, that the organism which has passed through this ordeal retains a transitory or lasting immunity against the development of similar disease germs.

I have believed myself obliged in the preceding pages to explain my views in relation to infection and contagion, and I have done so the more readily because I believe that, without these discussions, one is liable to sink back to the old empirical

standpoint. Through a knowledge of the new facts, however, one not only comprehends better the foundation processes of these diseases, but is likely to be incited to a more practical prophylaxis and one that rests upon a much securer basis than formerly. In answer, however, to the criticism, which has probably accompanied me through this introduction, I must state that we stand on the threshold of a better understanding of the theory of infection by parasites, and that in this department there still exists so much that is unknown and hypothetical that we can only receive and value its new doctrines with a certain degree of caution.

RELAPSING FEVER AND BILIOUS TYPHOID.

Recurrent typhus[1] is the name I have adopted for the disease known also as "*relapsing fever*," "*febris recurrens*," "*fièvre à rechûtes*." The name recurrent typhus seems to me peculiarly significant, since our mother-tongue should certainly possess a name for this disease, which is rapidly becoming naturalized in Germany, particularly in the north and north-east. Besides, Griesinger's designation, "febris recurrens," is best replaced by that of typhus recurrens.

Although bilious typhoid is but a form of relapsing fever, still it constitutes a special group by itself, and I shall therefore describe each separately. I should also add, that it still remains a question whether the same characteristic fungi are found in bilious typhoid as in relapsing fever.

I. RELAPSING FEVER—TYPHUS RECURRENS.

Rutty, A Chron. History of the Diseases in Dublin, 1770.—*Barker* and *Cheyne*, Account of the Fever lately Epidemic in Ireland. I. 211 (1819).—*Harty*, An Historic. Sketch of the Contagious Fever Epid. in Ireland, etc. Dublin, 1820.—*Graves*, Clinical Reports, etc. T. I. p. 50 et seq.—*Cormak*, Nat. History, Pathology, etc., of the Epidemic Fever, etc. Edinb., 1843.—*Craigie*, Edinb. Journ. Vol. 60. 1843. p. 410.—*Jackson*, Ibid. Vol. 61. 1844. p. 417.—*Henderson*, Ibid. p. 201.—*Smith*, Ibid. Vol. 61 and 62. 144.—*Goodsir*, Ibid. Vol. 63. 1845. p. 134—*Steele*, Ibid. Vol. 70, p. 145. Vol. 72, p. 669.—*Paterson*, Ibid. p. 362, 71.—*Engel*, Oesterr. mediz. Jahrbücher. 1846. Bd. III. 249—*Dämmler*, Virchow's Archiv. Bd. II. 1849.—*v. Baerensprung*, Haeser's Archiv. T. X. 4.—*Orr*, Edinb. Journ. Vol. 96. 1848. p. 363.—*Jenner*, On the Identity or Non-

[1] Beyond this paragraph, the expression "relapsing fever" will always be used in place of the author's "recurrent typhus."—TRANSLATOR'S NOTE.

identity of the Specific Cause of Typhus, etc. London, 1850.—Medical Times 1853.—*Christison*, Edinb. Journ. 1858. June. p. 577.—*Murchison*, A Treat. on the Cont. Fevers of Great Britain. London, 1862.—*Hirsch*, Handbuch der historisch-geographischen Pathologie. Bd. I. p. 168.—Bericht über die zu Gross Mosty epidemisch herrschende Febris recurrens. Russische allg. militärärztliche Zeitung 1866. Nr. 11. S. 93.—*Sacherjin*, Die Febris recurrens in Moscau. Wien. med. Wochenschrift 1866. Nr. 53–55.—*Azéma*, Note sur la fièvre recurrente qui règne à l'ile de la Réunion. Union médicale, 1866. Nr. 99.—*Herrmann*, Beitrag zur Kenntniss der Recurrens. Petersb. med. Zeitschr XII. Heft 1. S. 1.—*Kernig*, Ueber Milzabscesse nach Febris recurrens. Ibid. Hft. 4. S. 177.—*Arnould*, Du typhus à rechûtes, epid. observée à Ain-et-Bey. Arch. gén. de Médec. 1867.—*Riess*, Berlin. klin. Wochenschrift, 1868. Nr. 22.— *Wyss* and *Bock*, Studien über Febris recurrens etc. Berlin, 1869.—*Graetzer*, Ueber die öffentliche Armen-Krankenpflege und die Febris recurrens. Breslau, 1869, u. 70.—*Obermeier*, Ueber das wiederkehrende Fieber. Virchow's Archiv, Bd. 47.—*Murchison*, On the Reappearance of Relapsing Fever or Famine-Fever in England. Lancet, 1868. October 9, p. 503.—*Lebert*, Aetiologie und Statistik des Rückfallstyphus und des Flecktyphus in Breslau in der Jahren 1868 und 69. Archiv für klinische Medicin. Bd. VII. 1870. Hft. 3. 4, S. 385. Hft. 5. S. 461.—*Alonzo Clark*, On Relapsing Fever. New York Med. Record, 1870. March 1, p. 15.—*Parry*, Obs. on the Relapsing Fever as it occurred in Philadelphia, etc. Amer. Journ. of Med. Science, 1870, Oct., p. 336.—*v. Pustau*, Berl. klin. Wochenschrift 1869 und Virchow's Archiv 1870.—*Obermeier*, Ueber Pilzparasiten im Blute bei Recurrens, Centralblatt 1873.

HISTORICAL SURVEY.

Although it is only since the fifth decade of the present century that relapsing fever has been recognized with certainty, yet it has probably existed at all times in its own peculiar endemic centres in the British dominions, particularly in Ireland. Already in 1739 and 1741, Rutty mentioned an epidemic of the kind in Dublin. A similar one was described by Barker in 1801, and in 1817–19. In 1826, O'Brien and Graves made admirable observations on this disease. According to Duncan and Burne, the affection prevailed epidemically in Scotland in 1817–19.

A wider diffusion of relapsing fever, and a more generally disseminated knowledge of the malady, were first effected by the English, Irish, and Scotch epidemics which began in 1842. The first of these began in Kilkenny, spread over a large portion of Ireland, where it prevailed in connection with typhus fever, and

lasted until 1846. In Scotland the epidemic only lasted until 1844. The years 1847 and 1848 were not markedly "relapsing fever years" for Scotland and Ireland, but only so as regarded England. Ireland had been and still remained the starting-point of the disease, and it was continually being imported by Irishmen into both of the other countries.

The allusions made by Dümmler and Bärensprung to relapsing fever, as observed by them during the epidemic of typhus which prevailed in Upper Silesia in 1848, seem to me to possess only a secondary interest. Already, in 1846, Engel had proved the existence of relapsing fever as an epidemic in Bukowina, and had described bilious typhoid as a malignant variety of the disease. In 1847 relapsing fever was imported into New York from Ireland.

About the year 1850, Griesinger observed in Egypt, and particularly in Cairo, relapsing fever in connection with bilious typhoid and typhus fever. After this series of extensive outbreaks between the years 1840 and 1850 we hear no more, or at least only occasionally, of the disease, until it showed itself in 1863 in Odessa; then after this, for some years, it prevailed extensively, particularly in St. Petersburg. Subsequently we hear from time to time of a few localized and mostly inconsiderable epidemics in Bruges and Blankenburg, in Paris, in Algiers, in Galicia, in Siberia, upon the island of Réunion, etc.

Of especial interest in Germany is the appearance of the first few cases in Berlin, Greifswald, and other places, and then early in 1868 the outbreak of relapsing fever as an epidemic in Breslau and Berlin.

A lighter outbreak followed the first in Breslau again in 1869, and this time there appeared simultaneously an epidemic of typhus fever which soon spread far and wide. About the same thing occurred in Posen. By the end of 1872 we meet relapsing fever again in Berlin and in Breslau, where it lasted far into the year 1873, and a few cases appeared even in the summer.

I have thus given merely a general glance at the progress of the disease, and would only add now, that in all lands and during all epidemics the relationship between relapsing fever and typhus fever is shown by the following characters common to both,

namely, their great contagiousness, their tendency to attack the poorer classes and to make pestilential centres of lodging-houses and similar localities, overcrowded with vagrant and filthy persons.

For our first exact information in regard to this disease we are indebted to the Irish physicians and clinicians of the first half of the present century. Jenner had already, in 1850, admirably established the exact differential diagnosis and the most important characteristics of relapsing fever. Tholozan (Gaz. méd. de Paris, 1855, pp. 769 and 783) expressed similar views based upon his experience in the Crimean War. Confusion was again and again brought into this clear representation of the disease, and its relative position in pathology, by the suggestion of false and strained analogies with typhus fever, with intermittent, and with ordinary relapses of typhus fever.

Of great service is Griesinger's admirable description in Virchow's Pathology. For German physicians the independent existence of relapsing fever, with its most important characteristics, is definitely established, and we are indebted to our estimable co-worker in historico-geographical pathology, Hirsch, for a very valuable account of the various routes followed by the disease.

In the next place, the Russian physicians, with a broad basis of observation, have added greatly to our fundamental and practical knowledge. After Heimann, Pelikan, and Lewestamm had thoroughly described the Moscow epidemic in the winter of 1840–1, we find in the descriptions of the Odessa and St. Petersburg epidemics very interesting statements by Bernstein, Herrmann, etc.

The North-German epidemics of the last five years have given rise to a series of works, some of solid value. A detailed analysis, with an excellent description of the cases in my Breslau clinic, and of the epidemic of 1868, was given by Wyss and Bock, my assistants at that time. Graetzer, with his usual thorough, local knowledge and careful manner of collecting statistics, presented, after strict examination of the individual cases, a valuable contribution to the epidemiology of Breslau. The same holds good of Pastau's observations on relapsing fever made in All-Saints Hospital during the years 1868 and 1869. I have myself worked more particularly at the etiological department, especially as

regards the circumstances of locality, drainage, drinking-water, etc., in the epidemic of 1868 and 1869, of which I possessed the fullest possible data. The Berlin observations by Riess, Zuelzer, and Obermeier, and those of Griefswald by Mosler, are all worthy of notice.

Of the highest importance, finally, is the discovery made by Obermeier early in 1873, of the constant presence in the blood of relapsing fever patients of exceedingly thin, thread-like, spiral fungi. In my clinic we found their existence constant in the invasion and in the relapse. Our knowledge of the etiology of the disease is greatly advanced by these discoveries.

Thus in a few decades has the natural history of a previously very little known disease assumed the position of one of the most exact and interesting disease-pictures of pathology.

ETIOLOGY OF RELAPSING FEVER.

The earliest origin of an epidemic either results from an importation of the disease, or is so latent that even the closest examination throws no light upon the cause of the first case of sickness. In the latter case we must assume that the latent importation took place either by means of a previously sick individual, by materials from some infected locality, or by the development of these imported germs in the drinking-water before the epidemic broke out. The nidus of typhus and relapsing fever in Breslau was located in a quarter of the city (Great and Little Rose streets and neighborhood) which is supplied with such impure water that a whole fauna and flora may be found in it, as F. Cohn and myself have demonstrated. Drinking-water seems to me, however, to play a secondary rôle in the first importation and spread of the disease, as direct contagion is the more probable method of its introduction, favored as it is by overcrowding of human beings.

Later studies have caused me to abandon my earlier view of an autochthonous development, which at that time was as much justified by the facts as the view of importation. Great difficulties, indeed, are met with in accepting the view of the continuity of all cases of relapsing fever. Thus there lie between the Irish epidemics of the second, the third, and the fifth decade of this

century, long intervals, in which no allusion is made to relapsing fever. It is much more in accordance with the general laws of organic development to accept a continuous concealed existence of the germs, than to have recourse to spontaneous generation to account for their development.

Relapsing fever, since Obermeier's discovery, is certainly one of those infectious diseases for which a protomycetic origin has been most positively established. Obermeier, indeed, expressed himself guardedly in his paper in the "Centralblatt," remarking that he had not been able to distinguish these filaments in all cases of relapsing fever. Since the date of that communication, my assistants, Weigert and Buchwald, as well as myself, have examined the blood in all cases of relapsing fever under my care, with the aid of strong immersion lenses, and have arrived at the conclusion that these protomycetes are *never* absent during the periods of invasion and relapse, although they diminish very quickly after defervescence. Their number in each microscopic preparation is usually quite considerable, yet we have observed cases in which they were very sparingly present. In the beginning it seemed as though they were present in greater numbers in the mild, less intensely febrile cases; such a relation, however, did not prove to be constant. Thus far all attempts at cultivation or propagation have been without result; the number and variety of these experiments, however, have not been sufficiently great to allow definite conclusions to be drawn.

The nature of these spiral filaments is as follows: they are exceedingly slender, never exceeding in their diameter 0.001 mm., and in their length, 0.15 to 0.2 mm. Their form is spiral. In their interior I have been unable, so far, to make out either oil drops, sheaths, or structure of any kind. Their motion is very lively, rotatory, twisting, and rapidly progressive, but soon ceases under the ordinary conditions of microscopic examination. As the blood under examination cools and begins to coagulate, these movements become slower, and many spiral filaments become covered with very fine threads of fibrine. When the examination is made in serum alone, a certain number of the filaments may be observed frequently imbedded in a finely granular albuminoid substance. It may easily be understood that in this

manner thrombi may gradually be formed like those micrococcus thrombi observed by Waldeyer in the lymphatics in severer cases of puerperal infectious diseases.

Ehrenberg has already observed this species of protomycetes and described it under the name of spirochaete. Cohn, also, has given a short description of it in his treatise on bacteria (p. 160), and acompanied it with a drawing, Tab. III., Fig. 22. The variety described by these two observers is spirochaete plicatilis. Further investigation is necessary in order to determine whether the protomyces of relapsing fever is really a spirochaete or forms a new species. In the latter case it may with propriety derive its designation from the disease, and be called spirochaete recurrentis. Thus far we have sought in vain for this organism in the secretions and excretions, as well as in the internal organs; it is probable, however, that in the future it may also be found in these localities.

That a parasite so clearly determined as this, abounding in relapsing fever, and never having been found thus far in any other disease, must be closely connected with the development of, and spread of the affection in question, is hardly to be doubted. A very few of these spiral filaments, maintaining even an apparently torpid minimum of existence, are capable of spreading the disease from individual to individual directly, or indirectly, through the atmosphere, or various solid substances or fluids. It may easily be comprehended, also, that they can live on latently outside of the body in fluids, water, etc., until occasion brings them in contact with the human organism. Besides, by them the disease may easily be transmitted to distant localities, and thus these smallest of all vegetable organisms in the domain of science have a far higher value than the mountainous hypotheses of the past.

So soon as relapsing fever has appeared in any locality it spreads rapidly by contagion, but at the same time tends to form pestilential centres for itself, in which bad hygienic circumstances play an important part. On one hand, as already mentioned, stagnating and impure drinking-water is highly favorable to the nourishment of the specific parasite; on the other, crowding together of many poor and filthy human beings has a similar influence.

The ill-repute rightly possessed by Irish lodging-houses, in connection with this disease, has been confirmed in part, as regards Breslau, in that quarter of the city in which the Rose streets are situated. Here, however, a careful supervision of all the houses in these streets, in which many cases occurred during 1868 and 1869, has taught me that even those in which there were no night lodgers were likewise severely plague-stricken. In the last Breslau epidemic, towards the end of 1872 and during the first five months of 1873, this neighborhood played a much less important part, the explanation of which I have recently ascertained to lie in the fact that in Great Rose street the charge for a night's lodging has been doubled. As a result of this, the poorest, most shiftless, and vagabond of the population of Breslau (who can by no means be termed criminal, since temporary loss of work, or even less work than usual, makes temporary vagabonds), took refuge gladly in a new philanthropic institution. When first, as a result of the charity of certain citizens of Breslau, an asylum for homeless women was opened, we received into All-Saints Hospital for some time cases of relapsing fever, which came principally from this place or from localities into which the women sheltered in this asylum had imported the disease. Later, when an asylum for homeless men was opened, we received directly and indirectly from this institution also quite a number of cases of the disease. Not only did the beds, in which many individuals had slept one after another, but also the circumstance that often two had slept together, contribute to the spread of contagion.

Contagion is the more intense and frequent the closer the contiguity; thus all the members of a family living in one small chamber may be attacked. Similarly, male and female attendants and resident physicians in hospitals are more likely to suffer contagion than visiting physicians.

How quickly cases occurring in the same house may follow one another, my researches in 1868 and 1869 show. In not less than 27 per cent. the interval between new cases in the same house was only 1 day, in 16 per cent. 2 days, in 11 per cent. 3, in 5 per cent. 4, in something over 6 per cent. 5, in 6 per cent. 6, in 4 per cent. 7 days; in other words, 75 per cent. for the first

week, of which 54 per cent. occurred on the first 3 days ; for the second week of interval 10 per cent. remained ; for the third, 6 per cent.; for the fourth, 3 per cent ; and thus the figures become constantly smaller for the succeeding weeks up to a month. It follows from these figures that too much stress must not be laid upon the direct contagion from individual to individual, and that of the 54 per cent. taken sick in the first three days no small proportion may be otherwise accounted for. The most probable explanation for these is, that the pathogenetic protomycetes thriving in the drinking-water infect many persons in the same house at the same time, or after very short intervals, as we so often see in cholera. It is worthy of remark that in all epidemics occurring in my wards, in which thorough ventilation is maintained summer and winter, cases of contagion have been exceedingly rare.

If, now, contagion, and probably also infection by means of fluids, are among the principal elements of propagation, and if both find their chief place of origin in bad hygienic conditions, crowding together, and impure water supply, then the former view of the Irish physicians is contrary to that which I must take. This view, which looks upon relapsing fever as a famine fever, is one shared by Griesinger, as well as by my pupils Boch and Wyss, in regard to the Breslau epidemic of 1868. It is not borne out, however, either by the various epidemics which have appeared in Breslau, nor by the aspect of the relapsing-fever patients examined by me, who, on an average, presented a well-nourished appearance, in spite of their affording free board and lodging to no small number of eight-footed living beings. That occasionally a scarcity of food happens to occur in connection with an epidemic is not extraordinary. Has not the observation been made that each time a new opera by Meyerbeer has been in rehearsal, an epidemic of cholera has appeared? That hunger weakens, and therefore predisposes to infection, cannot indeed be denied ; but to believe that hunger infects is a little too much, and leads to the conclusion that the less an individual takes in, the more disease-poison does he receive into his body. This would be a new and unexpected application of the industry known as homœopathy, which laymen of the high proletariat believe themselves able to bring into accord with medical science.

House and chamber epidemics are more common than is the case with other infectious diseases. Of forty-six families, concerning which I was able to obtain exact information, there were in twenty-six cases two, in twenty cases three to six members taken ill; and indeed in sixteen instances two or even three persons were taken sick in one family on the same day, while in other cases the interval varied from a few days to several weeks. So here, in addition to the infection by contact, we must assume a simultaneous or quickly succeeding infection (by drinking-water or other means of direct contagion). Usually the women were first taken sick, then the children, and last of all the men. As in Silesia, the Grand Duchy of Posen, and in Ireland, so also in St. Petersburg, the epidemic of relapsing fever prevailed principally among the poorer class of people. When the laborers lived together in communities the greater part were frequently stricken down one after another. Zorn, to whom thanks are due for an excellent treatise upon this epidemic, expresses himself strongly to the effect that pauperism alone was not to blame in this case, since the means of subsistence were sufficient. Neither could it be imputed to the want of animal food, since during the fasting season a relatively small number of new cases occurred, compared to the immediately preceding and subsequent periods. In St. Petersburg, as in Breslau, alcoholism seemed of no great importance etiologically, since not only were women and children taken sick in greater numbers, but among the men a large number of such as were youthful, strong, and not given to drink. The influence of occupation was not established by my observations. The large number of children attacked is striking, amounting to one-third of the entire number of cases.

Not only are relatives and fellow-lodgers attacked by contagion, but also male and female attendants on the sick, and among physicians particularly the assistants who have the most constant relations with the patients.

A direct influence of sex cannot be admitted. An apparent, transitory difference depends usually upon transitory causes; thus, in Breslau, an outbreak occurred after a long interval, first in a female asylum, and much later in an asylum for men.

Aside from the great frequency of the disease in early childhood, the period from the twentieth to the thirtieth year alone presents more than a fourth, being the absolute maximum of cases. Between the ages of thirty and fifty the disease becomes less frequent, and after the fiftieth year is rare. There are more old women than old men attacked, and during the first five years of life there are more girls; on the other hand, in infancy more male children suffer from the affection.

In spite of careful observations I cannot, so far as Breslau is concerned, assert any meteorological influence; two were summer, the third a winter epidemic. Many other epidemics also, during which I examined the relations of season and weather, led me to conclude that no influence of the kind exists.

PATHOLOGY.

General View of the Disease.

A first latent period of incubation may be fixed, according to established data of contagion, at between five and seven days, but it may last a shorter or a longer time. There are usually no prodromata, or only those of malaise in general, lassitude, loss of appetite, weight in the head, restlessness at night, mostly of short duration. Characteristic, however, even in these exceptional cases with prodromes, is the quick onset of the disease itself. In the morning, in the middle of the day, less frequently in the evening or night, the malady begins with a high fever, which, however, in only about half the cases is ushered in by chilliness, and perhaps in one-fifth by a chill. This decided preliminary rigor lasts an hour or more, and may recur in a few instances. While in light abortive cases of the disease the patient may continue his ordinary vocation, yet in most cases the headache, with severe pains in the joints, limbs, etc., drives him to his bed immediately. The fever, intense and continued from the commencement, is accompanied by thirst and loss of appetite, less frequently beginning with nausea and vomiting. The burning heat of the skin is only occasionally tempered by the early appearance of perspiration. There is great debility from the

first. Soon after the onset the morning temperature exceeds 102.2° Fahr., reaching in the evening 104.0° Fahr., and in a few days the remittent fever shows morning and evening a temperature one to two degrees higher, that is, from 105.8° to 107.6° Fahr. The pulse becomes accelerated to 108 and 112 in the morning, and 120 and more in the evening. It is weak, though with tolerable fulness and tension; frequently quick, sometimes dicrotic. The skin, in spite of the high temperature, is usually moist; I have never observed roseola; miliaria occasionally appears somewhat late; herpes facialis is infrequent. The patient complains of a bad taste in the mouth, the tongue is thickly coated, and later dry. The bowels are somewhat constipated, or there is a slight intestinal catarrh, which is more frequent and persistent than the vomiting, which sometimes appears at the same time.

Already as early as the second day patients begin to complain of a feeling of weight and uneasiness in the upper part of the abdomen, approaching more nearly to actual pain in the left hypochondrium than in the right. A considerable enlargement of the liver, accompanied with slight tenderness, is usually observed, and the spleen becomes enlarged rapidly with painful symptoms of compression; not merely from day to day, but even from morning to evening its rapid, progressive increase may be established by percussion as well as palpation, and it frequently passes decidedly beyond the floating ribs. The muscles of the body, however, are the seat of the most severe pain. This pain is spontaneous during repose, and is increased by movement or pressure; it is situated in the muscles of the neck, back, chest, and abdomen, and in the upper and lower extremities. It is most severe in the latter, particularly in the calves. The character of the pain is splitting, piercing, boring, or more indescribable. The headache usually diminishes during the first days, while the pain in the limbs continues. Bleeding at the nose is rare. On account of the pain patients usually lie very quiet, almost immovable, but without that apathetic expression observed in other typhous diseases. Delirium is not a frequent symptom. The nights are not so much restless as sleepless, when the pain is severe. In spite of extreme weakness the mind is usually clear. The urine possesses the characters usual in febrile diseases, and not infre-

quently contains albumen. At the period of remissions there is a certain amelioration of the pain, particularly as the attack draws to a close; while in other cases, just before the crisis, an appreciable increase of all the symptoms sometimes takes place.

While the rapid loss of strength, the progressive emaciation, the high fever, the severe pains, the unusual enlargement of the spleen, portend a severe sickness, there follows, after a duration of five, six, or seven days, a sudden cessation of all symptoms. With the occurrence of profuse sweating the temperature falls in a few hours, more usually between night and morning, some five, six, even seven degrees, and at the same time with this decrease of temperature below normal, the pulse becomes decidedly less frequent, though not constantly so. It usually falls to the normal or sometimes even considerably below it. With the decrease of the fever, patients, as a rule, become more comfortable; the breathing, previously hurried and somewhat difficult, becomes regular; the pains in the head and limbs pass away, or at least diminish greatly. The thirst disappears, the appetite returns, the tongue becomes clear, the stools normal, the engorgement of the liver subsides, and the enlargement of the spleen rapidly decreases. At the same time the patient's strength returns to a certain degree; he leaves his bed and frequently insists upon being discharged from the hospital, in spite of the prediction of a relapse. This interval of freedom from fever lasts on an average for one week, sometimes only four or five days, rarely two weeks or so; and still more rarely the disease may be completed by this single paroxysm and the case go on to convalescence.

The relapse begins unexpectedly, sometimes in the forenoon, sometimes in the afternoon, but most generally at night. It may be ushered in by either a slight chilliness or by a marked rigor, or, on the other hand, neither may occur. On the first day the patient may either feel comfortably, in spite of the increasing temperature and pulse, or, and this is the rule, the relapse takes a similar course to the first attack; generally, however, with milder symptoms, except that the liver and spleen become just as much enlarged as before. The parasites of relapsing fever reappear in the blood immediately, and in as great numbers as the first time, to diminish once more on the approach

of convalescence. The remissions of the morning and forenoon are quite marked, and the relief of the patient at these periods is even greater than in the first attack. Sometimes a precritical defervescence precedes the definitive one, after which the temperature again rises, but only for a short time; while in other cases a marked increase of all the symptoms precedes, as a *perturbatio critica*, the remission by twelve to twenty-four hours. Though now the second relapse should be as marked, or even exceptionally more marked than the first, its duration is usually two or even several days shorter. Three to five days, then, may be regarded as the average, though I have seen it last seven to eight, while in other cases its course was almost abortive. The second critical defervescence, like the first, begins most frequently in the evening, or during the night, by a profuse perspiration, and by morning the temperature and pulse have usually fallen below the normal.

A third attack is not rare in many epidemics, as in Breslau during that of 1872–3, while in the epidemic of 1868–9 it was very unusual. The interval does not usually exceed four to seven days, though it may be longer; the relapse, while like the second as regards its brief duration, may present all the symptoms to a more marked degree, though it is usually milder and shorter on the average; I have even seen it, exceptionally, last seven days. I had not formerly believed in a fourth relapse until during the last epidemic several cases presented it undeniably.

A condition of comparative comfort succeeds to the definitive remission, during which all fever and pain disappear; but the emaciated patient still remains in a weak condition for a long while, suffering also from time to time from muscular pains. The appetite returns, in a few cases, very slowly, in most, however, with relative rapidity. The anæmic murmur, noticed often quite early in the neck and over the heart during the course of the affection, persists for a number of weeks later. Anæmic œdema is much more frequently present in some epidemics than in others. Convalescence lasts at least as long as the attack, the relapse, and the intermission; so that even in lighter cases patients are only exceptionally capable of going to work

again within a month from the beginning; while on the average six weeks, and not seldom seven, eight, or even more, reckoned from the commencement of the case, must be allowed. Even where there are no complications, fever may once more result from a neglected convalescence, as in typhoid fever. Fever, as well as other accidents, together with protracted delay in convalescence, may be induced by complications to which allusion will be made later, as well as by the return of a previous disease, which may appear with renewed intensity.

The result in the case of relapsing fever, by itself considered, is generally favorable, and, if bilious typhoid be excluded, the death-rate does not exceed 2 to 3 per cent. In those epidemics during which the mortality ranged from 8 to 10 per cent., bili ous typhoid was included in the account. Death may occur from the intensity of the relapsing fever and its consequent exhaustion, generally during the second attack; less frequently after repeated attacks, by progressive collapse. In other cases the fatal result is the consequence of complications. In the last Breslau epidemic this occurred particularly from pneumonia or from the aggravation of previous serious disease. To the unusual causes of death belong cerebral, uræmic, and hemorrhagic accidents. More commonly death may occur from localized softenings, or abscesses of the spleen, accompanied by chills and symptoms of pyæmia. I have, however, seen one such case terminate in recovery. Rupture of a single abscess may bring about death rapidly by means of highly acute peritonitis.

I shall now complete this general view of the disease by some observations on the more important elements of the affection.

Previous Health.

Previous acute diseases were in general only of accidental occurrence; even intermittent, so frequent with us, was without influence, and only presented any difficulty by the already enlarged spleen interfering somewhat with the diagnosis of relapsing fever.

It is a well-known fact that relapsing fever and typhus fever are apt to follow one another in the same individual, and that both present themselves in the same pestilential centre and geo-

graphical birthplace. That one predisposes to the other, instead of protecting against it, proves that both, indeed, may have a certain affinity, while still there are fundamental differences. In Breslau I have observed a peculiar relationship. Among those who had experienced relapsing fever in the summer of 1868, not a few, in fact whole families, were subsequently attacked by the most pronounced typhus; while in 1869, of those who had had typhus, only a few were subsequently affected by relapsing fever. I shall, however, draw no further conclusion from this, since the epidemic of typhus appeared after the first one of relapsing fever, and, indeed, during the existence of the second. This second one, however, was much lighter than the first, and thus presented but little material for the typhus. I possess exact accounts of fifty-three cases of relapsing fever, constituting 9 per cent. of the entire number of cases that occurred during these two years: they were all attacked with typhus fever, and constituted 7 per cent. of all the typhus cases. These successive attacks of the two diseases occurred most frequently between the ages of fifteen and forty, rarely previous to puberty; between the fortieth and sixtieth years nearly one-fifth of the cases occurred. The interval between the occurrence of relapsing fever and that of typhus in the same person varied between a few weeks and several months. Most surprising to me was the fact that among these fifty-three cases the mortality amounted to just 7.55 per cent., only half the mortality of our other cases of typhus. Can it be possible that after a previously experienced relapsing fever the typhus poison becomes less dangerous, or is this mere accident? The explanation of this question remains for futurity.

While relapsing fever prevailed, I observed that typhoid fever remained in the background. In both the first epidemics it seemed to me that relapsing fever generally attacked healthy individuals by preference. I reported, however, at that time a case in which the patient died of acute tuberculosis; at the post-mortem examination old deposits were found. Nevertheless, in the last epidemic I not infrequently observed relapsing fever in individuals already tuberculous, and also in those who had previously suffered from nephritis. These diseases seemed little influenced by the acute affection, and afterwards took up their

former course again. A previously stationary case of tuberculosis has remained in the same condition up to the present time, six months after the occurrence of the infectious disease.

Abortive Cases of Relapsing Fever.

As in all other infectious diseases, abortive cases are not unusual; they are not, however, as a general thing, observed in a hospital, but rather in the practice of the polyclinic. Probably in these cases the protomycetes of the disease do not find the circumstances of the locality and manner of their entrance, or of the predisposition of the individual, favorable to their development. That this explanation, however, is not sufficient to account for the various grades of intensity, is shown by the fact that the severity of the disease in the cases under our observation bore no relation to the number of protomycetes found. It is possible that according to the predisposition a great difference may result as regards the pyrogenetic products. Abortive cases may come to an end with the first light attack; or a second one may be observed in the hospital, of only two to four days' duration, and passing quickly on to convalescence; the first attack being described by the patients as light.

Febrile Symptoms.

Under this head we shall speak of the pulse, temperature, and urinary secretion consecutively.

1. *Pulse:* very rapid, attaining in the first twelve hours 108, 116, or even 120 beats to the minute, and in children thirty to forty more. The range is highest towards evening, being eight to twelve beats more at that time, and still more in a high grade of fever. A progressive increase does not take place during the attack, although for the temperature as well as for the pulse a high maximum may be observed immediately before the remission. With this stage the pulse quickly becomes normal; indeed, after a few days, sub-normal—52 to 48. Should the patient begin to leave his bed, a more frequent pulse is observed when sitting up than while in bed. The second attack is similar to the first.

In both the rate of the pulse often gives no indication of the temperature. During convalescence the condition of the pulse is governed by the varying circumstances of the period in relation to the patient's increase of strength, but it gradually becomes normal. The pulse wave is at first high, tension and fulness being marked, but later both decrease and the soft pulse is characterized by its compressible, vibrating, even at times dicrotic character.

2. *Temperature.*—The physician accustomed to estimate temperature finds in no other disease such surprising peculiarities in the range of heat as in relapsing fever. Thus I was able to make the diagnosis from the temperature curve of the first case of relapsing fever in my clinic in Breslau, early in 1868. As in typhus, the temperature rises rapidly, so that in cases where there is a rigor the temperature, even during the chill, measures 102.2° Fahr. and over. In the first few days the evening temperature reaches 104° to 105.8° Fahr.; and should it for a short time reach 107.6° Fahr., or even higher, it should hardly be reckoned as rare or prognostic of evil. The same is true of a continuously high evening temperature during the first attack. In the morning the average temperature is from 1.8 to 2.7 degrees less than in the evening. Occasionally it is 3.6 to 4.5 degrees less, and very rarely still lower. The curve of the attack extends over a period of from five to seven days, is remittent in type, and characterized by a high evening temperature. The rise and fall are by no means regular on different days. The temperature measurements, taken in a great number of cases, as frequently as every two or three hours, show an irregular variation in the rise and fall, from a few tenths to a degree and more, and it is not unusual to notice a higher temperature toward noon, or early or late in the afternoon, than in the evening. In rare cases, with very slight remissions, the daily curve is either an evenly high, or else a varying one, with similar temperature at the beginning and end. The maximum of temperature may fall upon the first day, the middle, or the last evening of the attack.

In no other disease is the remission so decided and so rapid as in relapsing fever. It is less frequently observed during the course of the day than in the evening or morning. It is usually

complete within six, eight, or twelve hours, but is in exceptional cases protracted. The average fall is from 5.4 to 10.8 degrees, or even, as I have observed in a number of cases, as much as 12.6 degrees, only exceptionally, however, one or two tenths beyond. These figures then bring the temperature down from 107.6° Fahr. to 96.8° Fahr. or 95° Fahr., sometimes even below. These measurements were generally taken in the axilla. The subnormal temperature sometimes gives place in the evening to a more normal one. Toward the end of the interval it already rises a little in the morning and becomes slightly febrile in the evening.

The beginning of the relapse is generally accompanied by a temperature of 102.4° Fahr. and over, which then rapidly rises and displays a similar aspect as in the first attack, but is sometimes more, sometimes less intense in one case or another. Not infrequently the maximum temperature of the entire disease is met with during the second attack. In the second attack also the fall of temperature is decidedly rapid. A free perspiration frequently accompanies the crisis. Should a third, or even exceptionally a fourth, attack occur, the symptoms will be similar, though of shorter duration. Transitory high temperatures during the interval possess no particular significance; if they last over twenty-four hours they usually point to some complication, at least such was the case during our last epidemic as regards pneumonia. In addition, there is not infrequently after the definite defervescence a transitory fever of one day's duration.

3. *Urinary alterations.*—These are not only such as are common to all fevers, but are very variable. If, with a diminution of the perspiration, the amount is not increased by drinking quantities of water, we observe the urine to sink in amount to a little over a pint and even less. The return to the normal, or even an increase over it, we observe usually on the first or second day following the remission. During the second attack the decrease in amount of urine is frequently less marked than during the first; the specific gravity remains, as usual in fever, in inverse ratio to the amount. The reaction is ordinarily acid, but it often becomes alkaline quite early. The coloration of the urine is deep where the amount is small; it is also cloudy as a general thing. The deposit may be either small or large in quantity, and consists of

the usual salts, urate of soda, urate of ammonia, less frequently of crystals of uric acid, or oxalate of lime, and in alkaline urine of triple phosphates. Some albumen is usually found in the urine during the first attack, as well as hyaline tube casts, which during the second attack contain more granular matter and oil globules. Much more marked are naturally the changes in the not unusual complication of nephritis. When icterus exists, biliary coloring matters are present in the urine, and I have also frequently found choleic acid by Neukomm's method. Careful volumetric examinations of the more important constituents of the urine, made during the last epidemic, by Mr. Müller, the apothecary, showed no elements in this secretion peculiar to relapsing fever.

Disturbances of the Nervous System.

Extraordinarily persistent in this disease is the intense headache, which commences with the onset and endures through the whole attack, disappearing during the intermission and returning again, though less severely, during the relapse. At the same time patients complain of a feeling of giddiness, which so soon as they get out of bed causes them to walk about like intoxicated persons, and they remain in bed the earlier days as much on account of this sensation as of the fever. With all this, however, there is seldom any delirium, and when this does exist it is only transitory. Neither do patients present the apathetic expression observed in other forms of typhus, their immobility being solely due to muscular pain, which is increased by any movement. These pains are among the most characteristic and grievous symptoms of the entire malady. They begin with the beginning of the disease, particularly in the lower limbs, and are very severe. Even where they were only slight I could produce them by pressure upon the middle of the calf (posterior tibial nerve). Pain in the small of the back is peculiarly severe during the first few days. The muscles of the neck, chest, and abdomen are in many patients the seat of less persistent pain, whether spontaneous or excited by pressure. The muscular pains increase with the paroxysm, and also change their locality. Patients very frequently liken their pains to those of exhaustion by over-use.

Articular pains are, for the most part, accompanied neither by swelling nor difficulty of movement. Even in the first attack great variations in the degree of pain may be observed; while it is almost unendurable in one case, in another it may be quite moderate, and during rest almost trifling. Peculiarly severe during the attacks, the pains almost cease throughout the interval (excepting at the beginning), and in the course of convalescence disappear entirely, leaving behind them, however, a prolonged and general muscular debility. In many cases, particularly among females, a general hyperæsthesia of the skin shows itself during the attack. Sleep is disturbed as much on account of the fever as the pains, while restlessness and sleeplessness are much less marked than in typhoid fever, and sleep may be said to be only interrupted by pains. The best slumber is obtained during the nocturnal remission. Persistent sleep and stupor are exceptional.

Disturbances of the Digestive Organs.

The extent to which the thirst and loss of appetite are connected with the feverish condition alone, is shown by the circumstance that during remission thirst disappears and appetite returns. Convalescence, however, is rather retarded by reason of disturbed digestion and catarrh of the stomach. In spite of the constantly coated condition of the tongue during the attack, it seldom and only transitorily becomes dry, and very rarely fissured. Nausea and vomiting of green or yellow fluid are not uncommon during the first few days, but they soon cease. Pain in the region of the stomach is usual at the same time. In the Breslau epidemics diarrhœa was frequent, and occasionally profuse; this is not unusual with acute diseases generally in this locality, and was not of grave significance. Involuntary stools only occur exceptionally in the severest cases.

Besides the usual enlargement of the liver already alluded to, which appears later than that of the spleen, but is not generally marked, icterus is not uncommon. The degree varies in different epidemics. While I saw very little of it in the epidemic of 1868 in Breslau, it was more frequent in the winter of 1872–3,

and still more so in the relatively small epidemic of 1869, at which time I observed also three cases of bilious typhoid. It is generally slight, appears during the early days of the disease, and diminishes rapidly during the remission. In other cases it is more persistent, intense, and accompanied by vomiting of bile. The patient becomes extremely prostrated, the stools are decolorized, and in this respect the intense ictero-hepatic form of relapsing fever resembles closely bilious typhoid. As has been observed, the urine during the persistence of icterus presents corresponding changes.

The spleen, in regard to the changes of which considerable stress has already been laid, is constantly enlarged, rapidly increasing in size from the commencement, and attaining double or treble its normal bulk ; it projects below the ribs, at the same time that it increases above and backward. The maximum of enlargement is attained at the end of the first attack; but in spite of the rapid decrease in size during the remission, the reduction is not complete, for, during the second attack, the spleen again becomes enlarged. At the beginning of convalescence the decrease in size is rapid, but it is a long time before the organ again resumes its normal proportions.

Disturbances of Respiration and Circulation.

Mild bronchitis is not infrequent in relapsing fever, and usually remains insignificant. Even previously existing lung affections present no aggravation of symptoms during the attacks. Allusion to pneumonia as a complication will be made later. Frequency of respiration is generally due to the fever alone.

With the exception of anæmic murmurs the organs of circulation usually present nothing abnormal ; weakness of the heart is observed to a slight degree, and, according to the testimony of English and Russian observers, may occasion sudden death from syncope. Irregular and weak rhythm is frequently noticed by the end of the first attack.

Hemorrhages may occur at different points: bleeding at the nose, to such a degree as to require the tampon ; rarely intestinal

and renal hemorrhages. Ecchymoses and petechiæ are alsc noticed. Uterine hemorrhage is very rare, excepting where in pregnant women it is connected with abortion, which is very apt to take place in this disease.

COMPLICATIONS AND SEQUELÆ.

While in former epidemics in Breslau pneumonia was very seldom observed, yet in that of last winter we noticed it quite frequently, as indeed had been previously the case elsewhere. It contributed not a little to swell the mortality, which amounted to about three per cent. of the entire number of cases. It usually appeared during the attack or during the relapse, was decidedly inclined to become double, in mild cases went on to improvement and recovery, while in more severe cases it was the cause of death. The hemorrhagic pachymeningitis not infrequently observed in the St. Petersburg epidemic, I have seen only a few times; the same has been my lot as regards iritis, choroiditis, and retinitis. Secondary inflammations, subcutaneous abscesses, inflammation of the parotid, belong, though rare, to the secondary complications; the same may be said of dysentery. When there is nephritis, it has usually existed before the attack of relapsing fever; it very seldom occurs as a sequela; one such case, however, which resulted fatally, came under notice in my clinic. Alcoholic delirium is proportionately infrequent, and usually results favorably, a new proof that drunkards are not peculiarly liable to relapsing fever.

In very rare cases the splenic enlargement persists a long time after the remission, accompanied by considerable fever. If abscesses form in the spleen, these may give rise to rigors followed by pyæmic symptoms or rupture of that organ, causing death or a very tedious convalescence.

Of the various forms of relapsing fever we have no especial remarks to make. An abortive, a light, a moderately severe, a severe, as well as an ictero-bilious form may be distinguished. Bilious typhoid, however, is a disease which I cannot look upon merely as a form of relapsing fever; I shall therefore describe it separately.

PATHOLOGICAL ANATOMY.

If relapsing fever and bilious typhoid are regarded as distinct, then all pathognomonic peculiarities are wanting for the former. Besides this, during the last epidemic at Breslau we sought in vain for protomycetes in the spleen, lungs, and other organs, although the possibility of their existence can by no means be denied. In all cases the spleen, when death does not occur at a late period from some complication, is decidedly enlarged, its smooth capsule very tense and slightly clouded. The dark, reddish-brown parenchyma is only firm when the trabecular tissue is highly developed, otherwise it is soft; the surface on section is either homogeneous or shows the Malpighian corpuscles with unusual distinctness; here and there are decided deposits of pigment. In many cases a considerable number of roundish or irregular miliary aggregations of a dull yellow color are found, containing granular detritus, with occasionally cell elements and free nuclei. These are found, too, in the lymph follicles, and may be observed in different sections in all stages, from a simple follicular enlargement to the aggregations of detritus. If the spleen is very soft, almost diffluent, no decided structure can be made out. In many post-mortem examinations, and these were not infrequent during the last epidemic in Breslau, there are found larger wedge-shaped infarctions, similar to the aggregations referred to, but more irregular in form as well as without any demonstrable embolic origin. They, too, may be observed either firm or softening and breaking down. Should the patient die after passing through the actual attack, the enlargement of the spleen is found greatly reduced and the capsule wrinkled. The liver likewise displays, even in those dying during the course of the attack, an enlargement, which, however, in proportion to that of the spleen, is much less marked. The acini present in part a cloudy, pale appearance. In rare cases the liver presents small deposits, similar to those found in the spleen, with central softening. Even when death occurs late in the course of the disease, the parenchyma of the liver still shows a certain turbid engorgement. The gall-bladder is more or less

full, and generally contains a clear yellow or brownish bile. The kidneys are slightly swollen, and present, like the liver, a moderate decoloration of the cortical portion and turbid engorgement, as well as granular infiltration of the urinary tubules. The pale cortex is, however, succulent, and somewhat broader than normal.

In the digestive organs slight glandular swellings are occasionally met with, particularly in the solitary follicles of the intestine and in the mesenteric glands. These, however, are few in number, and cannot be compared with the enlargements in typhoid fever. Minute extravasations of blood are sometimes found in the mucous membrane of the stomach, and occasionally in other mucous and serous membranes. The respiratory organs present no peculiarities when complications do not exist; but certainly during the last Breslau epidemic many patients perished of pneumonia. This pneumonia, which might be either single or double, presented the usual appearances of diffuse inflammation of the lungs, the remaining parts of which were also œdematous.

The heart showed no changes excepting in complications; in protracted cases, however, fine granular infiltration of the muscular fibres could be observed. The blood of the heart is partly fluid, partly in process of coagulation, and occasionally mixed with fibrinous clots. The muscles of the body show, here and there, not very infrequently, finely granular, abundant infiltrations into the muscular fibres, irregularly arranged, amounting sometimes to fatty degeneration. The muscular rigidity, which appears soon after death, persists for a considerable period.

DIAGNOSIS.

The course of relapsing fever is so characteristic that even in the beginning of an epidemic a mistake can scarcely be made, providing the temperature be noted. At least the only time during which there can be any doubt is in the course of the first stage. Even then, however, the rapid and considerable increase of temperature, the extraordinary enlargement of the spleen, the very characteristic muscular pains do not admit of any confusion

with typhoid or typhus fever. The roseola accompanying the former is wanting, while herpes facialis, which is never observed in typhus, is often observed in relapsing fever. The enlargement of the liver, and the tenderness in the neighborhood of both liver and spleen, are peculiarly diagnostic. Not less characteristic is the rapid but decided fall of temperature, even below the normal point, and the return, after a feverless period, of all these symptoms which, after the relapse terminates, again rapidly disappear. Much has been said in regard to the relation of relapsing fever to intermittent—a very unfortunate because unjustifiable idea, not only contradicted by the temperature curve, but put entirely out of the question by the manner of attack, its duration, its remission, the length of the interval, the termination of the process with two or at most three attacks, and the great contagiousness of the former.

PROGNOSIS.

If relapsing fever and bilious typhoid occur separately, the prognosis is much more favorable, as was the case in the great Russian epidemic. I have already observed that the mortality in Breslau during three epidemics did not rise above 2 to 3 per cent. Even if we admit that it may rise to 5 per cent. and somewhat over, the prognosis of relapsing fever may (independently of bilious typhoid) still be regarded as the most favorable of all the typhous diseases. Severe as it may seem during the onset, yet rapidly, often theatrically, the scene alters from evening to morning. Only in very severe cases, with marked weakness of the constitution, does death ensue from the first attack or the second. Most cases dying of relapsing fever perish not from the disease but from some complication, as, for instance, in our last epidemic from pneumonia, in that of St. Petersburg from pachymeningitis hæmorrhagica, and in other cases from various complications, as acute nephritis, etc.; very rarely from rupture of the spleen.

TREATMENT.

Prophylaxis is the first thing to be attended to. The question here is not, as stated usually in theoretical works, What *can* be

done, but what *should* be done, from a sanitary point of view? Relapsing fever is indeed contagious, as typhus is; but as the same stringent rules are not enforced for the little-feared measles as are in force for the small-pox, so dreaded in regard to its extension and mortality, so the same rigor is not required in relapsing fever as is necessary in a typhus or cholera epidemic. I do not regard it as necessary to force all such sick of the poorer classes into an isolated hospital; indeed I hold it entirely unnecessary even to cause the cases of relapsing fever to lie exclusively in separate apartments. In all epidemics of relapsing fever that have occurred here I have had many cases of the disease in my general wards, where by excellent ventilation and by scattering the patients I have kept the proportion of cases of contagion at a minimum compared with that occurring in relapsing fever wards. That the various centres of epidemic influence should be cleaned, aired, whitewashed, and as far as possible the remaining disease germs destroyed, is undoubtedly true, but often this cannot be done. How, in the epidemic of 1868, would it have been possible to cleanse the entire Rose district in Breslau? In the last epidemic both asylums for the homeless were, as we have seen, hot-beds of infection; but it would have been exceedingly inhuman to have closed these most excellent and philanthropic institutions. It is well, however, under such circumstances, to care for the airing, whitewashing, sulphur fumigation, and disinfection generally, not only of the apartments but also of the beds. Especially, two persons should not be allowed to sleep in the same bed. The necessity for perfect cleanliness and free ventilation, even with systematic isolation, is easily understood. Prophylaxis, however, is most to the purpose, as I shall explain when treating of typhus fever. Since relapsing fever, like many other infectious diseases, is peculiarly liable to be transmitted by means of soiled clothing, everything of the kind should be thrown into boiling water as soon as taken off, and remain there some time before being washed. The bedding should be rendered, if not entirely innocuous, at least as nearly so as possible by fumigation with sulphur, by heat, sun, and air. All materials of little value which cannot be disinfected, as straw for instance, should be burned. The system of visitation, which will

be discussed later in connection with cholera, should also be put into practice in relapsing fever. It is highly probable that improvement in the quality of the drinking-water, especially its separation from soil and sewage infiltration by proper means of supply, will cut off more and more from relapsing fever the nidus of its germs.

As to any particular therapeutic resource, my recent as well as my former experience has demonstrated the fact that there is no drug which may be said to exercise any direct influence upon the course of the disease. Even large doses of quinine and repeated cold baths, excepting that they reduce the fever decidedly, are not effectual. The expectant plan of treatment therefore is the only proper one. Rest in bed, fresh air, cleanliness, fever diet, milk, soups, meat broths, cooling drinks, are the principal things to be attended to. If the patient has an appetite, if he can take nourishment, he should have not only more but better fare,—vegetables, stronger soups, meat, and particularly wine. Clear pure water and carbonic acid water are, as a general thing, the beverages best borne. If drugs cannot on moral grounds be entirely avoided, I usually give small doses of phosphoric acid, such as ten drops of the dilute acid every second hour in a tablespoonful of sweetened water. The severe headache is best combated by means of bladders of ice, which it is not necessary to keep continually applied, but only during the paroxysms. The muscular pains may be ameliorated by frictions with equal parts of oil and chloroform employed every second or third hour. When the pains are very severe, hypodermic injections of morphia may be given. In pain over the splenic region cold applications frequently renewed, or continuous poultices, the effect of which is the same, may be used. If weakness increases, more wine should be given, and when symptoms of collapse threaten I usually order an ammoniated tincture of musk—(℞ Moschi ʒ j., Ammonii Carb. gr. xxx., Aq. destill. fl. ʒ v., Alcoholis fl. ℥ ij., Ol. Menth. gtt. v.)—thirty drops of which are to be taken in a tablespoonful of sugar and water, or wine, every hour. Obstinate diarrhœa is to be combated by alum, tannin, nitrate of silver, and opium. In case of delirium tremens, chloral hydrate in fifteen-grain doses may be administered every hour until one

to two drachms have been taken. When pneumonia occurs as a complication, it is to be treated by counter-irritation, the anisated spirit of ammonia,[1] benzoin, musk, wine, and derivative vesication. Abscesses, particularly those of the parotid region, should be opened early and treated with Lister's dressing. Severe bleeding at the nose, if at all persistent, is best arrested by the early and complete application of tampons. During the convalescence of patients who have become exceedingly exhausted, good invigorating fare is best supplemented by tincture of cinchona or mild preparations of iron, particularly the lactate, given to the amount of from three to eight grains daily, in pill form, with extract of gentian.

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[1] Oil of anise, one part; alcohol, twenty parts; water of ammonia, five parts. —*German Ph.*

BILIOUS TYPHOID, TYPHUS BILIOSUS.

Callisen, Obs. circ. epid. bilioso-nervoso-putridam inter nautas, etc. Act. societ. med. Havn. Vol. III. p. 1 ff.—*Larrey*, Mémoires de chirurgie militaire. Tom. II. Par. 1812.—*Lange*, Eigenthümliche Milzkrankheit—oder Typhus? in Beob. am Krankenbette. Königs., 1850. p. 285.—*Griesinger*, Beob. über die Krankh. von Egypten. Arch. für physiol. Heilk. XII. 1853. p. 29.—*A. Hirsch*, Handb. der histor. geogr. Pathолog. 1859. p. 172.—*Griesinger*, Virchow'sches Handbuch. Bd. II. Abth. II. pag. 272.—*Lebert*, Beiträge zur Kenntniss des biliösen Typhoids. Deutsches Archiv für klinische Medicin. Bd. VI. pag. 501.

As far as I am concerned it is as yet an undecided question whether bilious typhoid and relapsing fever are identical, and consequently only different forms of the same disease; or whether, although nearly related, they are not essentially different varieties of typhus. Griesinger expresses himself decidedly for the former view, Hirsch is doubtful. Until proof to the contrary is brought forward, I should declare myself in favor of non-identity. While in great epidemics, like that at Cairo and in the last St. Petersburg epidemic, numerous cases of bilious typhoid were observed in connection with relapsing fever, there have been, however, many epidemics—even in Ireland, the home of relapsing fever—in the course of which bilious typhoid did not occur, although it has shown itself commonly in others (Graves, Cormack). The case has been similar, with few exceptions, in the North-German epidemics of the last five or six years. In Breslau, out of three epidemics, I have only observed in one, and that the lightest (1869), three cases of bilious typhoid, and these presented an entirely different physiognomy from the usual relapsing fever. In the two more severe epidemics not a single case of this nature came under my notice. Relapsing fever accompanied by icterus is indeed not uncommon, but the latter appears to be merely an unessential complication, as we observe it in other acute diseases, pneumonia, typhus, etc.

In other epidemics, indeed, bilious typhoid occurs more frequently, and then the otherwise trifling mortality of relapsing

fever rises to double, threefold, and over. The individual years, too, show, on their part, a difference of mortality in direct relation to the appearance of bilious typhoid. Relapsing fever does not, as a general thing, vary from its average relapsing course, while many recent researches seem to show that although bilious typhoid may pursue a relapse-like course—as has already been observed, to a certain degree, in yellow fever—it quite often shows a decided inclination to a continuous course. The geographical distribution, too, is not consistent with the view of identity. While, for instance, bilious typhoid displays a decided preference for localities in which relapsing fever is present, and for epidemics of the latter, on the other hand there are localities in which bilious typhoid presents itself unaccompanied by a single case of relapsing fever. It would be entirely unjustifiable to look upon the disease only as a more seriously terminating, frequently bilious form of relapsing fever. The solution of this question might be promoted during the next epidemic of bilious typhoid, if a careful and thorough examination of the blood should be made by competent microscopists. Should examinations in severe cases of the fever show that the spiral protomycetes discovered by Obermeier are not constantly present, this would weigh against the doctrine of identity. Should they be found, however, this could certainly be used as an argument for identity, although having no decisive value. Who would venture to assert that all infectious diseases in which globular, or all in which rod-like protomycetes are found are identical? And if such a conclusion is inadmissible for these, neither can it be employed in the case of the spiral forms. We leave the question open, therefore, and, while having a personal inclination toward non-identity, we admit a close relationship between the two diseases.

ETIOLOGY.

We will give here a short historico-geographical view, following chiefly Hirsch and Griesinger. Hirsch draws attention especially to the spread of bilious typhoid along the eastern coast and among the islands of the Mediterranean Sea, where it was par-

ticularly observed by physicians of the English navy in the Ionic islands, Malta, Minorca, etc. In describing it they used indifferently the terms Mediterranean fever, and bilious remittent. Hirsch cites a short but very characteristic description of the disease from Burnett,[1] who had already alluded to the relapse which frequently follows. The following passage from Hirsch[2] is also important: "Whether bilious typhoid is to be regarded as an epidemic disease for the coasts of Greece and Turkey cannot for the present be decided. Rothlauf described a typhus epidemic of the year 1835, in Athens, which it is highly probable was one of bilious typhoid, and Rigler declared that he had observed typhus icterodes to be very frequent in Constantinople in 1843, and to be extremely malignant, compared with other forms of typhus. Reference should here be made to the work of Frari on the typhus epidemic of 1817, in Spalato and other localities in Dalmatia, in which the description of the disease is that of bilious typhoid to the life. Finally, we find a notice by Aubert of the occurrence of this affection on the coasts of Asia Minor; from this it appears that there prevails in Smyrna, during the autumn, a peculiar species of typhus accompanied by jaundice. Floquin has described this under the name of typhus icterodes. Floquin's work is unknown to me; probably, however, it treats of the same disease which Röser has observed and described under the name of "yellow fever." I must allow the question to remain undecided, as to whether the disease in question is actually bilious typhoid or the febris remittens biliosa of Clarke, described and alluded to above."

In Nubia, also, according to Russegger, a malignant bilious typhoid appears to prevail, which is infectious. The same is probably the case in the East Indies, if we may judge from the accounts of Annesley and Twining, and in the West Indies, according to Barclay's works. With still greater certainty does Hirsch regard this disease as the cause of some of the epidemics which have prevailed with peculiar fatality among negroes in the United States, particularly in Philadelphia and North Carolina. The works of Graves, Stokes, and O'Brien may be particularly

[1] A Practical Account of the Mediterranean Fever, etc. London, 1816.

[2] Op. cit., Vol. I., p. 174.

mentioned as alluding to the presence of bilious typhoid during British epidemics, in connection with typhus fever and relapsing fever. A peculiar epidemic of this disease has been observed by Goodsir in the district of Fife (Scotland); it occurred without any trace of relapsing fever. Hirsch reckons under this head the French epidemics which Lemercier (1822) and Rollet (1832) observed, as well as a Swiss epidemic which Moser saw in Wetzikon, and certain cases in Königsberg, which Lange has described, and upon which Griesinger rightly lays great stress. Of very great importance is the Russian epidemic of 1840 and 1841, which we find thus described in Hirsch: "We possess, finally, a very interesting and entirely unequivocal account of this disease from Russia, where bilious typhoid prevailed epidemically in Moscow during the winter of 1840–41, and was observed by Heimann, Pelikan, and Lewestamm. They describe it in the following words: 'In the beginning of the epidemic the disease presented itself clinically and anatomically as a simple typhoid; at a later period, however, peculiar variations were noticed in the course of the affection; the patients seemed strangely exhausted, the conjunctiva and skin appeared of a yellow tint, and acute pain was experienced in the left hypochondrium, particularly upon pressure over the region of the spleen, which seemed distended. As the disease progressed these symptoms grew more marked: the jaundiced tint became deeper; vomiting, hiccough, and sopor alternating with delirium, followed; and finally picking at the bedclothes and death. Towards the end of the epidemic (March, 1841) this form of the affection disappeared and simple typhoid took its place.' From the results of post-mortem examinations made by the observers alluded to—results which agree closely—it is established that in bilious typhoid, contrary to the condition observed in typhoid fever, the intestinal mucous membrane is found intact. The entire disease process seems to be concentrated upon the liver, and especially upon the spleen; the latter is always decidedly enlarged, often to double and threefold its ordinary size, or even more. Usually it appears pulpy, softened, and containing white, tubercular bodies, the size of a lentil, scattered through it; sometimes it is enormously

swollen and ruptured. A comparison of these facts with the observations of Griesinger establishes the nature of this disease beyond question."

Griesinger's description, which is elaborated from his rich Cairo material, may be rightly regarded as opening the way for the reception of bilious typhoid into pathology. The name, also, is fortunately chosen; but it seems to me that his view is too exclusive and absolute in regard to the identity with relapsing fever, as well as in relation to the miliary deposits in the spleen, which I do not look upon as belonging constantly and necessarily to the process either in relapsing fever or bilious typhoid. It is probable also that bilious typhoid was not the cause of those small local epidemics, of which Griesinger speaks (p. 286), which had been previously observed by Budd in England, later by Jacob in the Roman army of occupation (1850), and one of which has come to my knowledge as having occurred in one of the forts during the siege of Paris. The cause of the latter was ascertained to lie in the fact that for a whole month the excrementitious material could not be removed. Cases of this kind I have regarded for the last twenty years as typhoid icterus, and have attributed them with the highest probability to a peculiar septic element of infection which is not propagated by direct contagion.

True bilious typhoid may occur at any period of life; it seems, however, to have a preference for older children and youth, and while the disease proceeds from some primitive element of infection unknown to us, its development is greatly forwarded by crowding, misery, and filth. Its contagiousness does not seem clearly established to Griesinger; he remarks that he has had no opportunity to convince himself of the fact. This is one reason more for regarding the identity of the doubtfully contagious bilious typhoid with the highly contagious relapsing fever as by no means established. With swamp fever and malaria, in the usual sense, this etiology has nothing to do.

SYMPTOMATOLOGY.

My own experience being small, I shall make use of Griesinger's description. "The disease begins with pain in the head,

vertigo and faintness, and apparently, as a rule, with chills. Soon lancinating pains are experienced in the limbs, particularly in the muscles and joints of the lower extremities, and occasionally they attain great intensity. A continuously feverish condition now becomes developed, with a frequent, full, and throbbing pulse, restlessness and gastric symptoms, thickly coated tongue, repeated vomiting of watery or bilious matter, and some soreness of the epigastrium.

"Many patients manifest even at this early period decided exhaustion, absent-mindedness, and marked apathy. The fever increases gradually during the first few days; later, in most cases, more rapidly and considerably, so that the aspect of the disease may alter completely in a single day. The temperature now reaches an unusual height, the skin is dry, sometimes red, turgescent, and sweating, the headache intense, the eyes injected, there is marked vertigo, roaring in the ears, a cloudiness of the sensorium, as in drunkenness, and great muscular weakness; the tongue becomes dry and often swollen and cracked; there is bilious vomiting, increasing soreness over the epigastrium, and, in particular, diarrhœa sets in, sometimes almost of a dysenteric character. Closer examination shows numerous quickly appearing localizations: often bronchitis or pharyngitis; always, however, and without exception, enlargement of the spleen, at times occurring early and noticeable even in light cases, more frequently commencing later and extending to the border of the ribs, often extending even a handbreadth beyond. This is accompanied in most cases by decided soreness, and soon after there is observed a similar soreness in the right hypochondrium, accompanied by a slight enlargement of the liver. With the development of these symptoms icterus very frequently makes its appearance, although not constantly; generally on the fourth or sixth day from the beginning of the disease; occasionally, however, some days later. Extreme weakness, great apathy, a still hot skin, though no longer turgescent, dry tongue, all these continue; the pulse falls off rapidly and decidedly in frequency, but remains full; an appreciable enlargement of the spleen continues for some days longer.

"Many patients die during this stage, generally in unexpect-

edly sudden collapse; in others a rapid and general improvement (with or without perspiration) takes place, they continue for several days in apparent convalescence, when suddenly there comes—as happened in a single one of mine (Griesinger's) but particularly in Lange's cases—a relapse, with all the earlier symptoms, but now tending often to a rapidly fatal termination. In still other cases, frequently coming under my observation, the condition depicted lasts without any decided remission, and develops the group of symptoms known, in a narrow sense, as 'typhoid': prostration, stupor, half soporific condition, quiet or noisy delirium, dry, crusty tongue, and involuntary, thin stools. The pulse is now, as a rule, slow, but may be, exceptionally, frequent and small; the jaundiced tint becomes more intense; the abdominal walls, particularly over the hypochondria, are tender; the thin stools are dark green, often, however, decidedly dysenteric, rarely accompanied by any considerable amount of clotted blood. Vomiting frequently persists; hoarseness, difficulty of swallowing, with croupous deposit on the mucous membrane of the pharynx, bronchitis, extensive lobar pneumonia, and occasionally pericarditis are developed; petechiæ and sudamina appear upon the skin. In the evening the fever increases; irregular chills, exacerbations of temperature and sweats occur, while the general condition grows worse. A fatal termination may then result, either with sopor and slight convulsions, or in a sudden collapse; occasionally it occurs even after previous improvement, or from some chest affection; sometimes, too, from some particular cause, as internal hemorrhages (rupture of the spleen). Or an abatement of the symptoms takes place, which at times progresses rapidly and generally, so that between morning and evening the volume of the spleen is found greatly diminished; within two days the mind may become quite clear, the tongue moist and almost clean, the pulse normal, and the appetite and bodily strength may return. In other cases, particularly where widespread and severe local affections of the thoracic and digestive organs (pneumonia, dysentery, etc.) have appeared, a varying amount of fever remains, which is slow to disappear, and is accompanied to a certain extent by typhoid symptoms. Con-

valescence is slow, and the gradual diminution of splenic enlargement may last through six to ten days.

"Convalescence among my cases was, as a rule, rapid and easy; in Lange's cases it was protracted and tedious. Acute marasmus with œdema, prolonged dysentery, gangrene of the toes, tuberculosis, were very rare sequelæ.

DURATION OF THE DISEASE.

"The duration of the entire disease was, in my more protracted cases, on an average ten to fourteen days; cases in which death or convalescence took place after a five or six days' course were, however, not unusual. Bilious typhoid seems also to have its full share of light cases; these sometimes resembled true relapsing fever, and sometimes, when no relapse occurred, could with difficulty be distinguished from the febricula of other typhoid affections. When the symptoms once become developed in such a manner that the disease may be regarded as true bilious typhoid, the prognosis must be considered as in any event very grave. Two-thirds of Lange's cases ended fatally; Larrey also had a high rate of mortality. In my experience the mortality under the expectant treatment was likewise very great, but when I afterwards employed quinine in large doses it was quite small."

So far as the cases observed by me are concerned, my experience agrees with that of Griesinger in all respects; but in my cases the course was continuous, taking decidedly a typhoid character. Peculiarly characteristic in the first case were the icterus, the enlargement of the liver, and the pain over the hepatic region; at the same time the spleen was decidedly increased in size, albuminuria persisted a long time, and secondary infiltrations showed themselves in the lungs. Gradually the liver symptoms disappeared, the urine became normal, and the spleen decreased in size; but the secondary local troubles in the thorax had not yet healed, when he left the hospital, six weeks after the commencement of the disease. At no time were there chilly sensations, nor any signs of hepatic colic. A general disease was evidently present, and the simultaneous prevalence

of relapsing fever established the diagnosis of an affection belonging to the typhus group, most probably bilious typhoid. Griesenger brings forward this multiplicity of local troubles as one of the characteristics of bilious typhoid, and ascribes to it the continuous course of the fever, which under these circumstances may be much protracted.

The second very interesting case was an acute one, ending fatally, after nine days' duration, with a typhoid course throughout, and marked icterus. Already at the end of a few days, a bed-sore made its appearance on the lower part of the buttocks, extending to the perinæum; it came more suddenly and made more rapid progress than I have ever observed except in a rapidly developing spinal paralysis. The course of the attack was continuous, with remissions and exacerbations, and a number of chills, symptoms which have been mentioned also by observers of the Russian epidemic as belonging to bilious typhoid. From the lack of all anatomical signs of septicæmia or pyæmia, as well as of contusion or injury of the buttocks and region of the perinæum, and from the appearance of the tumor for the first time during the course of the disease, it was evident that this was one of those peculiar decubital tumors met with in typhus, which are so prone to run into gangrenous degeneration. Against the idea of its being a simple phlegmon, we have the rarity of this affection in the region in question, as well as the appearance of the tumor at a later period than the fever and other symptoms of disease, and the extremely small amount of suppuration that preceded the gangrenous condition. The large, soft spleen, and the alteration of the liver, answer very well to the description of bilious typhoid; no small abscesses of the spleen were present, it is true, but their absence, as we have seen, is in nowise unusual.

The third case was that of a man seventy-six years of age, who had previously only suffered from catarrh of the stomach. He took sick rapidly, became jaundiced, lost consciousness and hearing, presented an enormous frequency of pulse without rise of temperature, and sank within a period of six days. On opening the body, no cause of death was found connected with any former or latent disease. This then must be set down as

a decided case of typhoid icterus. I have not infrequently observed ordinary jaundice in the aged, but never with such a tempestuous typhoid course. There were no signs of poisoning, much less did the liver show the characters of diffuse hepatitis, of purulent catarrh of the bile-ducts, cholelithiasis, or any new growth whatever. In a word, it is impossible to overlook the typhoid course and character of the affection, and since it occurred in the course of an epidemic of relapsing fever, it seemed reasonable to designate it as a case of bilious typhoid. The ecchymoses of the skin, the pleura, and the bladder also pointed in the same direction. Equally interesting was the fact established in both fatal cases, and confirmed by other observers, of an enlargement of the glands of the small intestine. For further details I would refer to my original article on the subject.

PATHOLOGICAL ANATOMY.

Petechiæ and ecchymoses are found at quite an early period, as well externally as internally, upon the mucous and serous membranes. The organs are generally deficient in blood, and diphtheritic exudations often exist upon the mucous membrane of the pharynx, extending even into the larynx, and sometimes assuming an ulcerous character. Enlargement of the bronchial glands, bronchial catarrh, lobular centres of collapse, or more considerable infiltrations of the lung, are observed. The blood contained in the cardiac cavities of the heart is fluid or thick, with soft, yellow, fibrinous clots. The liver is enlarged, soft, icterosed, more or less full of blood; perihepatitis is not rare; the bile is generally thick and dark, its excretory ducts are permeable. The spleen is usually very large, soft, dark-brownish red, and has sometimes been observed in a ruptured condition, as Griesinger noted in three out of 101 cases. According to the same author, the spleen is frequently found studded with many small grayish-yellow Malpighian corpuscles, filled with exudation and already showing the characters of small abscesses. I regard these miliary deposits as not constant, either in relapsing fever or in bilious typhoid, and have even found them once in typhus

fever. Fresh infarctions and wedges of fibrine are also found in the spleen. The stomach displays at times extensive hemorrhagic erosions and acute catarrh. The small intestine contains much yellow-colored material; there is frequently catarrh, occasionally markedly developed croup of the ileum, as well as various forms of the dysenteric process in the great intestine. The mesenteric glands are frequently acutely enlarged and infiltrated, in a few cases being as pulpy as in ileo-typhus; the glands about the stomach, the spleen, the portal region, and the retro-peritoneal glands show withal decided enlargement. The glands of the small intestine Griesinger indeed did not find infiltrated, although in two cases I found them slightly enlarged. The kidneys are swollen and cloudy, and there is often catarrh of the pelvis. After a somewhat long duration the splenic infarctions may break down. When death has taken place at an advanced stage of the disease, the icteric liver is more flabby, and various secondary, diphtheritic, hemorrhagic, and inflammatory localizations are met with in various parts of the body.

DIAGNOSIS.

This is not always easy, even during the prevalence of relapsing fever, particularly when in the severe cases the course of the disease is more continuous. The intense jaundice, the rapid and decided enlargement of the spleen in connection with the increase in size of the liver, have, on the one hand, a decided value, while on the other the absence of all signs of purulent inflammation of the biliary ducts, the portal vessels, the parenchyma of the liver, or of pyæmic or septicæmic processes, to which the disease in question may have some similarity, usually decides the diagnosis. While the appearance of the other diseases mentioned is sporadic, and even rare, bilious typhoid usually shows itself epidemically. Should relapsing fever be prevailing at the time, the diagnosis is much easier. Besides, bilious typhoid generally makes its appearance only in places where it has prevailed before. These circumstances may aid in the diagnosis, which becomes much more difficult when the dis-

ease appears sporadically or in places where it has not appeared before.

The physiognomy of the affection is so decidedly typhous in character that if septic and purulent blood poisoning can be excluded; if, which is not difficult, one can convince one's self that the case is one of typhus disease, and not simply a typhous state, the existence of an essential typhus may be firmly maintained. Now, in no other form of typhus does jaundice show itself so early and so constantly; in no other, relapsing fever excepted, does the spleen become so rapidly and markedly enlarged, or is a relapsing course, or an approach to it, so common as in bilious typhoid. Besides, in icterus gravis, yellow atrophy of the liver, or phosphorous poisoning accompanied by icterus, the course of the disease is quite different. There is a certain similarity to yellow fever, but this has a totally different field of operations from bilious typhoid. Its violent outbreak upon certain coasts, the enormous ravages which it effects in a short time, the intense pain in the loins, the vomiting of black matter, the less decided inclination to secondary localizations, usually enable the diagnosis to be easily established. The spleen, moreover, is by no means so decidedly involved, nor does the enlargement take place with similar rapidity in yellow fever as in bilious typhoid. From remittent malarial fever the disease which we are considering is easily to be distinguished, since it possesses neither the etiological nor the clinical characters of intermittent fevers, characters which accompany the malarial remittent almost invariably. Even the attacks and the feverless interval of recurrent bilious typhoid have not the slightest similarity to the short, periodic attacks of the malarial disease.

PROGNOSIS.

This is always grave; the danger is disproportionately greater than in relapsing fever; the continuous variety is much more serious than the recurrent, and in the latter the second attack is more doubtful as to result than the first. In addition, the various secondary local affections, which occur during or after the principal disease, present no small danger. The mortality

seems to vary greatly in different epidemics, though exact statistics are still wanting upon this point. Heretofore, where relapsing fever and bilious typhoid have prevailed together, the mortality of one has not been distinguished from that of the other with sufficient exactness, and consequently the prognosis in both cases has been brought into confusion.

TREATMENT.

All that has been recommended therapeutically under the head of relapsing fever may find place here in the lighter forms, although, as regards prophylaxis, the prevention of contagion is not so important a matter as in relapsing fever. Moreover, weakness and tendency to collapse are much more frequent in bilious typhoid; consequently stimulants, wine, preparations of ammonia, benzoin, camphor, musk, are more often indicated. Large doses of quinine, which Griesinger extols as an antipyretic, may also be useful during the more continuous period, as well as repeated cold baths.

TYPHUS FEVER.

PETECHIAL TYPHUS—TYPHUS EXANTHEMATICUS.

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HISTORICAL NOTICE.

The earlier accounts of typhus fever by Ætius, Actuarius, Zacutus Lusitanus, and Despars are doubtful, to say the least. In this historico-geographical notice also, we are indebted to Hirsch (op. cit., p. 149), who finds the first satisfactory account in the year 1501, when Fracastoro first described exanthematic typhus as a new, unheard-of disease introduced from Cyprus

into Italy, which for a period of twenty years seemed to have been extensively disseminated throughout Italy, as during the same time it spread quite generally over the European continent. Gradually, during this and the following century, the so-called spotted fever seems to have been the predominant form of typhus among the epidemic diseases.

As at that time military expeditions and the movements of armies contributed largely to its extension, so again, during the great and general wars of the first fifteen years of the present century, typhus fever spread generally over Europe, after which it became localized for thirty years, to break out again and become prevalent on the Continent during the past ten years, over a larger extent of territory and with a greater frequency; while Great Britain and Ireland have always remained its birthplace. Among the deserving authors who have described this disease is Pringle, who has written a very excellent report of the epidemics of 1742 and 1745, particularly those occurring in the English armies.

The work of Hildenbrandt on contagious typhus is classical even now, and furnishes a very complete description of the great epidemics of the Napoleonic wars. In the series of the more important works is that of Rasori, which is very interesting historically, but is full of anti-stimulation theories and exaggeration. Among the later writings, the most important as to description and theory are the works of Virchow and Lindwurm on the typhus of Upper Silesia and Ireland. The best general descriptions I know of are those of Wood and Griesinger. Hirsch has admirably stated the circumstances and causes of dissemination.

Recently the frequent breaking out of this disease has given rise to a great increase in its literature.

In Great Britain the majority of the authors mentioned in connection with relapsing fever have won deserved praise for their descriptions of the epidemics of typhus fever, and in Murchison's work is to be found a particularly good account.

ETIOLOGY.

The immediate cause of typhus fever is unknown. Though even now in relapsing fever there exists a definitely proven *formation*, connected with the origin of the disease, yet neither in typhoid nor typhus fever has such an organism been discovered. But that some such a typhus-germ, of the fungous group, whether microsphere, bacterium, or spiral formation, is the immediate cause, seems at least much more probable than any other idea. All the later authors agree that the disease is spread by a typhus-germ. Where contagion plays so important a part, one is necessarily compelled to admit a specific germ for a disease so absolutely defined and so well characterized. Such can only be an organic poison or an organized germ. A poison may kill, but cannot infect, still less spontaneously multiply to an enormous degree; while everything in the history of this disease admits a ready explanation through organized germs, confirmed by a series of distinct analogies, as I have shown in the general work on the relation of parasitism to infection: on the other hand, there is no exact scientific fact favoring the existence of a purely organic poison.

Though we deeply regret the lack of an exact knowledge of this specific germ, we must lay all the more stress upon the other etiological circumstances, thereby not only promoting the natural history of the disease, but also throwing a certain amount of light upon the logical postulate of the immediate cause and its nature.

Geographical Distribution.

As India is the birthplace of cholera, Lower Egypt of the plague, a part of the Atlantic sea-coast of yellow fever, so is Ireland, so far as history teaches, the most prominent, if not the only, birthplace of typhus fever, and the reports of the endemic and epidemic occurrence of this disease in all parts of Ireland have very decidedly increased since the end of the last century,

according to Hirsch, particularly in 1797–1803, 1815, 1817–1819, 1821–22, 1825–27, 1834, 1836, 1842, and 1846–48. How great the ravages have been at times, is to be seen from the fact that from 1817 to 1819 there fell sick 800,000 of the 6,000,000 inhabitants of Ireland, and of these 45,000 died, partly from typhus fever, partly from famine and dysentery.

Typhus has followed the Irish emigrant everywhere, and with him and through his means has become naturalized not merely in the other British islands, but also in North America and the West Indies.

Though Ireland is the main centre, it is not the only one.

In the Russian provinces bordering on the Baltic, and in Poland, petechial typhus is of frequent occurrence, and often widely diffused. Galicia, Silesia, the grand duchy of Posen, East and West Prussia, are much more frequently infected than the surrounding countries. In Silesia the years 1847–48, 1856–57, 1868–69, are notorious as years of pestilence; the latter being likewise typhus years in East and West Prussia, and in the province of Posen. In Breslau I have seen sporadic cases of typhus fever nearly every year, but only once (1868–69) an epidemic.

In other parts of Germany—as Westphalia, Hanover, the Prussian parts of the Rhine, Spessart, of late years in Berlin also—typhus fever has occurred only as isolated epidemics. The same is true of Sweden, Denmark, Holland, and Belgium. After the great campaigns of the beginning of this century, typhus was so rare in France that even men of considerable authority sought almost to deny its existence, and as Parisian science was particularly the fashion, the epidemics in the prisons of Toulon, of Rheims, etc., were not sufficiently attended to.

Italy again affords endemic centres, particularly Northern Italy, from which the pestilence extends over middle Italy, and farther south, even into Sicily. Nearly all which has been observed in Switzerland originated in Italy. In the spring of 1839 I observed an epidemic in the lower Valais, on the plain and in the valley of Salvan; this was introduced from Piedmont, over the St. Bernard, where at least a third of the monks were suffering from the disease.

In Zurich, also, the disease has been introduced from Italy at various times; recently, as Griesinger records, after the Italian campaign of 1859. In Hungary, where, in the middle ages, typhus was very destructive as the "*Febris pannonica;*" also in Wallachia and Turkey, typhus has of recent years existed only temporarily; latest of all, very extensively during the Crimean war.

In Asia, particularly in English India, Hirsch states that typhus occurs endemically only in Simla.

In the United States of North America typhus was originally introduced by the Irish, but has prevailed at different times as epidemic over a large extent of territory; while it occurs much more rarely and less severely in English North America. Its extension into the Antilles, etc., by English troops, has never reached any great degree.

The spontaneous origin of typhus was formerly believed by many pathologists. I myself have explained in this way certain facts observed in the Crimean war, as its rapid and unexpected origin before Sebastopol, with the occurrence of the cold, damp season; also its breaking out in a war vessel fifty days after the departure from Kamiesch.

At present the idea of a spontaneous origin seems to me to be in opposition to all the facts of the germ (protomyces) theory, and the above-mentioned observations, as well as the sudden and unexpected occurrence of the disease in connection with improbable importation, on which Murchison lays stress, admit, I think, of another explanation. Small quantities of typhus germs may have remained latent in these places, or their importation may have taken place from typhus regions, by infected articles, which may have escaped the closest scrutiny.

All pathologists are united in agreeing that typhus propagates itself through peculiar specific germs, in which lie the essence of contagion.

Whatever one may think concerning these germs, it is much more in accordance with natural science that the fact of their increase should depend on pre-existing germs, rather than upon spontaneous generation, a theory continually *further and further banished* into the realms of hypothesis.

In but few diseases is the contagion so evident and so frequent as in typhus fever, and it increases particularly with the duration of the closer contiguity; therefore in hospitals, for instance, the nurses and assistant-physicians are much more frequently attacked than the visiting physicians and students. Dr. Anderson, who suffered from typhus at the Fever Hospital in Glasgow, told me that the assistants there, as well as in the English fever hospitals generally, rarely escaped the disease. Every article coming in contact with typhus patients may serve to transport and extend the disease, a fact only to be explained by the presence of a subtle agent capable of living even in a dried condition, and there is no other than the germ idea which offers even a relatively like degree of probability. Washer-women, who wash the non-disinfected linen of typhus patients, are very strongly predisposed to the contagion, as our epidemics in Breslau have proved.

The more numerous the typhus patients are in a limited space, the more powerful naturally does the contagion become, and the more readily will the air and inanimate objects, water, etc., take up the typhus germs and transport them further; therefore the danger of the pestilence in prisons, on shipboard, in camps, everywhere, in a word, where numerous individuals are confined to a limited space. Aggregation alone naturally does not produce typhus; but is the latter once introduced, it finds in the former a frightfully favorable basis for extension and destruction. On the other hand, I observed during 1868 and 1869, that in my hospital wards, which were well ventilated, even in winter, the disease was not propagated. None of us physicians, none of my students who visited the wards, were at that time infected.

There were certain pestilential centres—main depots of the disease—in Breslau, as in all large cities. The two Rose Lanes, containing only twenty-eight houses, furnished, in 1868–69, 30 per cent. of all the cases, and, if we include the adjoining cattle market, we have a total of nearly 36.56 per cent. This part of the city was much more uniformly infected with typhus than with relapsing fever, though in both instances the same houses furnished the largest number of patients. Ebers records similar

ratios for the Rose district, in the great epidemic of typhus in 1856–57.

The water examined by Colm and myself was the worst in all Breslau, and presented a real fauna and flora of parasites, as well as traces of direct pollution from human excreta. By taking into account that a part of the Rose district lies somewhat lower than the surface of the neighboring Oder, and that generally in Breslau the compact clay lies quite near the surface, thereby favoring the stagnation of the ground-water, it seems at least probable that with such poorly isolated and impure wells the ground and drinking waters offer the most favorable nidus for the development of the typhus germs which may have been received, and that through them the citizens are infected, until finally these dangerous germs are supplanted by harmless ones, according to the general laws of parasitism.

The manner of the extension in individual dwellings and houses, in the above-mentioned epidemic, favors the influence of local conditions; where numerous cases occurred, they arose simultaneously, or with an interval of a few days only. While in many houses there were but few patients, in certain ones there were very many—in No. 12 Great Rose street, for instance, 36 cases. Though in general the period of incubation may be regarded as from five to seven days, we find the following ratios of sequence in the same house for the first five days.

In 57 cases an interval of 1 day.
" 45 " " " 2 days.
" 35 " " " 3 "
" 32 " " " 4 "
" 30 " " " 5 "

In all 199 cases, to which may be added 59 cases arising simultaneously in the same house. In 258 of these 481 cases thus investigated, that is, 53.64 per cent.—more than one-half—the sequence of cases of diseases took place so rapidly, that extension by contagion from one to the other could not be considered. Another means of infection than contagion must be admitted here, as in relapsing fever, and indeed in most conta-

gious disease, and thus one always returns again to local conditions, among which the ground and drinking waters must probably together play the important part, and conceal the infecting germs, which then, through contagion probably, *increase very considerably* the further development and progress of the pestilence.

We find also in Hirsch a series of facts confirmatory of this, for he proves, both for typhoid and typhus fever, that a very damp or marshy soil in many places favors the development of these diseases; and yet, on the other hand, like conditions cannot be proven for many endemics and epidemics of typhus. According to the germ theory, it is conceivable that typhus germs, like all similar organisms, find an excellent breeding-place in the ground water, and as this falls they are drawn deeper into the ground, contaminating the well water, or, rising to the surface, enter the human organism by currents of water or air. It is also obvious that it would be irrational and entirely opposed to the natural history of fungi to seek for the place of development of the typhus germs in the ground and drinking waters alone. Contagion simply is the best proof to the contrary, showing that germs emanating from the body may proceed from one to another in the most manifold manner. It would be well worth while to study carefully the fungi of the air and of the water in typhus wards, and to compare them with those of other wards, in which there are no cases of typhus.

Incidental to the influence of the aggregation of many individuals in confined spaces, with regard to the etiology of typhus, we have further been persuaded that typhus fever predominates much more among the poorer classes than among the wealthier. Nevertheless, the epidemic at Breslau has taught me that contagion is not always the chief cause, or even one that can be proven, but that in typhus regions and their vicinity the wealthy also may share in the numerous simultaneous attacks just as well as in the later secondary ones—explainable by contagion.

During the Breslau epidemics I have collected exact data in more than 740 cases with reference to the occupation. Among

men, the laboring classes predominated, particularly those employed in the open air, while those working in shops—as joiners, locksmiths, cobblers, and tailors—furnished a much smaller quota. The number of children of both sexes was remarkably large.

The number of male and female nurses and hospital servants was relatively large, 5.8 per cent.—these coming in direct contact with the typhus patients. In All Saints Hospital six physicians were seized; in the monastery of the Hospitallers one died; in the latter place a student was also infected; further, a relatively large number of the Hospitallers fell sick, thirteen among 171 persons. It is true that one or more of these may have been infected in the city.

A superintendent of the prisons belongs in this category, also four deaconesses, and a nurse in the Bethany, among twenty-two patients in this institution. Towards the close of this epidemic I learned of fifty-seven cases who were treated at home, and who in great part belonged to the wealthy middle class; among these no order was favored—there were merchants, apothecaries, higher officials, students, well-to-do artisans, etc.

It was long ago asserted by Irish physicians that typhus fever was particularly a disease due to famine, a view brought forward recently also, and advocated by Virchow. According to my idea of the infectious diseases, and in accordance with what I have said in connection with relapsing fever, I must, very naturally, decidedly oppose this view. It is very likely that bad food among the poorer classes, packed together in confined spaces during the years when crops have failed, may favor the spread of the disease; but famine does not infect. The more enfeebled the organism is, the more does it seem to be predisposed to infectious diseases in general, and to typhus in particular. I have put the question in a different way, however: In what relation can the failure of crops and years of scarcity stand to epidemics of typhus fever? I have thus been led to the possibility of both having a common basis in atmospheric and telluric influences which are unfavorable to successful crops, but favor the growth of the infecting parasites. Years of dearth are generally permanently cold and wet; a lower, moderate

temperature has probably a much less influence on the ground-water than upon the superficial soil devoted to cultivation, and a permanently high degree of moisture in the earth is very favorable to the growth of lower organisms, and can then promote their diffusion and dissemination through the air and water.

The meteorological conditions are by no means constant in the different epidemics, and typhus is still more independent of the seasons, than typhoid fever, as has been proven by Hirsch in his analysis of the periods of occurrence of thirty-five epidemics. The conditions of the weather, especially with regard to temperature, have hitherto been found to possess no decided influence. Nevertheless I firmly maintain what I have just stated, that the influence of the rise and fall of the ground-water may possibly be great; yet I would not lay too great a stress upon this, though favored by what we know of other infectious diseases, particularly of typhoid fever in Munich. With this corresponds the fact that a series of observations exists, which show that typhus occurs with a certain predilection in low and damp places (Hirsch, l. c., p. 183 and 184), though Hirsch properly insists that these elements are by no means necessary for the production of typhus. Through importation typhus may occur tolerably high above the sea-level; for I observed quite a number of cases in 1839 in the Salvan Valley, which lies nearly 4,000 feet above the level of the sea, they having been transferred from the plain below.

There is no law of exclusion between the occurrence of typhus and intermittent fever.

The influence of sex and age is shown, since the greater number of cases occur among males than females. In accurate records of 740 cases, 55.68 per cent. were males, 44.32 per cent. females.

This preponderance is still more decidedly seen in the total number of cases—1,100—occurring during the epidemic. With regard to age, my results obtained at Breslau agree in general with those of other authors. As it is desirable to collect numerous exact statistics on this point, I record the following analysis of 740 cases:

Age.	Males.	Females.	Together.
0—1 year.	0=0.0 per ct.	0=0.0 per ct.	0=0.0 per ct.
1—5 years.	9=2.2 "	11=3.4 "	20=2.7 "
5—10 "	21=5.1 "	14=4.3 "	35=4.7 "
10—15 "	33=8.0 "	25=7.6 "	58=7.8 "
15—20 "	72=17.5 "	47=14.4 "	119=16.1 "
20—30 "	103=25.0 "	66=20.1 "	169=22.8 "
30—40 "	83=20.1 "	87=26.5 "	170=23.0 "
40—50 "	53=12.9 "	46=14.0 "	99=13.4 "
50—60 "	31=7.5 "	24=7.3 "	55=7.4 "
60—70 "	7=1.7 "	6=1.8 "	13=1.8 "
70—80 "	0=0.0 "	2=0.6 "	2=0.3 "

Collectively the greatest number of cases existed between the ages of 20 and 40 years, viz. ; 45.8 per cent. The number was less in the decades preceding and following : 15-20 years, 16.1 per cent. ; 40-50 years, 13.4 per cent. ; further, a symmetrical diminution took place towards old age on the one hand, and infancy on the other.

Up to one year there were no cases ; between 60 and 80 years, 15 occurred.

The affection of the sexes varied according to the age. The following differences were found between males and females, according to the sex :

Age.	Excess of Males over Females.	Excess of Females over Males.
0—1 year.	0.0 per ct.	0.0 per ct.
1—5 years.	0.0 "	1.2 "
5—10 "	0.8 "	0.0 "
10—15 "	0.4 "	0.0 "
15—20 "	3.1 "	0.0 "
20—30 "	4.9 "	0.0 "
30—40 "	0.0 "	6.4 "
40—50 "	0.0 "	1.1 "
50—60 "	0.2 "	0.0 "
60—70 "	0.0 "	0.1 "
70—80 "	0.0 "	0.6 "

According to this table, the female sex was the more prone from 1 to 5 years ; from 5 to 30 years the males were more sub-

ject; from 30 to 40 years, the females predominated, and retained their position, with a slight variation between 50 and 60. We may therefore say, that during the first half of life, up to 30 years, males more frequently suffer from typhus fever than females, the reverse being true of the second half of life.

A very varying individual predisposition, or immunity exists for typhus fever, as for all contagious diseases. Ordinarily, it occurs but once in a lifetime; according to my Breslau experience, a previous attack of relapsing fever increases the predisposition. Typhoid fever neither protects from, nor predisposes to typhus, nor have I been able to see entire disappearance of the former during an epidemic of the latter. The intensity of its occurrence, with reference to the numbers of the diseased, is quite varied. In Breslau I have observed every year solitary cases or local epidemics, but only during the year 1868 and 1869 a severe epidemic.

In the epidemic of 1856–57, I have calculated that 3 per cent. of the entire population of Breslau fell sick; in 1868 and 1869, on the contrary, scarcely two-thirds of 1 per cent. In the smaller villages, in 1839, I have seen almost a third of the inhabitants sick.

The history of the epidemics of the first twenty-five years of the present century shows a very extensive distribution, both at their beginning on the continent, as well as later in Great Britain, and Ireland in particular, while at other times the epidemics were much smaller and much more locally limited.

SYMPTOMATOLOGY.

General Description.

An attack of typhus fever is often preceded by prodromes. Such are more or less severe pains in the head, neck, and limbs, a loss of appetite, nausea even, and sometimes vomiting.

The patient is dull, out of humor, and despite a feeling of extreme fatigue, is unable to sleep, and is restless at night. These prodromes rarely last longer than a few days, though exceptionally they may be more protracted, as in typhoid fever.

Most patients still make an effort to work, while others are compelled to give up, or take to bed, even during these premonitory symptoms. A complete absence of the prodromes may occur, particularly when the course is rapid, and in severe cases; on the other hand, after a short duration, they may terminate in a slight febrile disturbance, during which the patient may move about, even after the eruption has appeared, and make a rapid recovery after its disappearance. English physicians call this abortive form of typhus fever febricula, and I have often seen such patients walking into the out-patient department.

The actual beginning of the disease is, in general, marked, often characterized by a chill, though less frequently than in typhoid fever. The rigor, as well as slight chilliness, may be repeated at intervals during the following days, so that one might think of intermittent fever. At times the onset is associated with vomiting, which is often repeated for a few days, especially among children. Whether a chill has occurred or not, there exists from the outset a fever which rapidly becomes intense; and this first stage of the disease, up to the appearance of the eruption, may be called a congestive-febrile one. When the fever appears the skin is hot, often slightly reddened, especially that of the head and face, the cheeks being red and swollen, the eyes somewhat red. During this period the patient complains of an extremely severe and constant headache. The head is likewise heavy and confused,—so that many patients, even early in the disease, feel a sort of giddiness, complain of being dizzy on sitting up or leaving the bed. Noises in the ears is a frequent symptom. The pains in the limbs and joints are more severe than in typhoid fever. Symptoms of catarrh are not uncommon, as sneezing and slight sore throat. The pulse is very decidedly quickened from the beginning of the fever, from 96 to 108 in the morning, from 112 to 120 or more in the evening, according to the severity of the attack; the acceleration being much greater in childhood, especially in infancy. At the outset the pulse is full and decided, its volume and tension being rarely increased to a higher degree; but it speedily becomes soft and easily compressible, and finally feeble. It is rarely dicrotus, while it is well known that reduplication of the pulse is the rule in

typhoid. It is only in the severest cases, and then late, that it becomes feeble and irregular. Several times, in very severe cases which proved rapidly fatal, I have found the frequency of the pulse to be moderate, even below the normal. This condition, combined with the profound sleep of such patients, suggests a striking resemblance to acute forms of grave cerebral diseases.

The ranges of temperature are of the greatest importance with reference to the quality and intensity of the fever. The rise of temperature is generally rapid; in the morning of the third or fourth day being 103° to 104°, and in the evening from 104° to 105.8°, remaining at these points with tolerable constancy during the entire first week. An evening temperature of 107.6° is seldom reached, still more rarely exceeded. In the first half of the second week the temperature is generally decidedly elevated, though in the favorable cases even then showing a tendency to a critical fall. I must warn against the mistake in prognosis of regarding those cases with high fever as very severe, from the high range of evening temperatures. It is only the permanently high morning and evening temperatures which establish the grave prognosis. For the rest, the greater and the longer the remissions in the morning are, the less dangerous is the high evening rate.

Muscular weakness and a feeling of extreme prostration are remarkably pronounced and increase rapidly; notwithstanding the frequent intense character of the pains in the limbs, joints, and back, the patients present a peculiar look of profound, apathetic quiet and insensibility, while at other times even slight pains become increased by movements.

Even early in the severe cases the movements are unsteady, tremulous, to be seen also when the tongue is protruded and the patient speaks. Such symptoms occur relatively late in the course of typhoid fever. At the outset, answers to questions are generally correct, but the patient soon becomes indifferent again, or falls into a slightly drowsy condition. Despite this apparent quiet, the patients pass uncomfortable, restless nights. Wakefulness alternates with bad dreams, there is also delirium, and even those apparently the most quiet try to leave the bed or the room during the night, and hence require the most care-

ful watching at this time. From the very beginning of the fever the tongue is coated, at the outset with a white, later with a thicker and yellow fur, with a decided tendency to become dry; there is a bad taste in the mouth; the secretion of saliva is diminished; a stale, acid, even offensive odor proceeds from the mouth, and there is thirst and loss of appetite. Vomiting is rare after the first few days, and then temporary constipation is present. Such was the case at Breslau, particularly among the wealthier classes; while among the poor, intestinal catarrh and moderate diarrhœa were of no rare occurrence even early in the disease. While otherwise the abdomen remains soft and free from pain, the enlargement of the spleen can be determined by percussion even quite early; at the same time the rapidity and intensity of the splenic swelling are not as marked as in relapsing fever, consequently the disagreeable sensations in the region of the spleen are wanting. In the beginning, a catarrh of the conjunctiva or of the nasal or buccal mucous membrane is more common; a few days later a low degree of bronchial catarrh takes place, at times accompanied by laryngeal catarrh, hoarseness, and difficulty in swallowing. In rare cases I have seen a severe bronchitis appear as the main feature of the disease, just as in the severe bronchitic forms of typhoid fever. The congestive-febrile stage at the beginning of this disease is accompanied by manifold catarrhs, analogous to the acute exanthematous affections.

In spite of the numerous peculiarities of the various forms of typhus[1] fever, petechial typhus more than all the others shows an additional point of contact with the infectious exanthemata, and I have often called the attention of the students in the ward to the resemblance between a fresh and extensive typhus eruption and that of measles.

In the second half of the first week, particularly towards its close, the characteristic eruption generally appears; it is by no means rare for it to occur at the end of the week, and I would call particular attention to the fact that I have seen cases of typhus fever in which there was no rash at all. The rose-

[1] In the German sense of the term.—Translator.

ola of the exanthematic form of typhus does not perceptibly differ in quality from that of typhoid fever; here also I have seen a very extensive eruption, but exceptionally. Further, the eruption is in general characterized by being much more abundant on the chest, abdomen, back, extremities, and even on the face. The spots are often much more numerous on the extremities than on the trunk; when on the face, I have found them particularly marked among children. The small, round, rosy spots present rarely a slightly papular elevation above the surface of the epidermis. I have been unable to see that the eruption exercises any influence upon the diminution of the fever, as has been observed in measles. That the eruption is intimately connected with the progress of the disease, is to be seen from the fact that it was very pronounced and profuse in more than eighty per cent of the cases. During the first few days the spots disappear on pressure, whereas, later, blood-coloring matter or blood-corpuscles get outside the capillaries, and the spots no longer fade under pressure. At the same time it is incorrect always to regard spots at this stage as petechiæ. The same condition occurs in the roseola of typhoid fever; but the real spotted extravasations of blood, true petechiæ, show themselves to be such from the beginning; they remain longer and disappear more slowly; while the spots which have become darker fade much more quickly, and disappear with or without desquamation. Though true petechiæ may appear anew after the roseola, a portion of the spots of the latter in severe cases are converted into permanent dark-red stains, whose course is no longer typical, whereas the true rash fades, as a rule, during the first half of the second week, and disappears during its close.

The pronounced redness and swelling of the face and eyes during the first week, often end, in the latter instance, in a conjunctivitis, an occurrence much more common among females than males during the late epidemic in Breslau.

A stage of thorough depression at the close of the first and beginning of the second week now follows the previous congestive febrile condition, with its still distinct phenomena of excitement. The complete impairment of the mental powers is very pronounced, while the attacks of delirium are more rarely severe,

constant, or boisterous. Hebetude, slow and incorrect answers to questions, drowsiness, coma, and stupor are always more decidedly prominent. The patient is usually dull of hearing; since the feeling of thirst has diminished, the tongue becomes dry and fissured, the yellow coat becomes browner, crust-like; a dusky hue about the mouth and nose is not uncommon; the redness of the face diminishes more and more, and in severe cases the patients have a look of profound prostration, favored by the rapidly increasing emaciation. The quickened pulse, which ranges from 110 to 140, becomes small, at times jerking or dicrotus, in rare instances irregular. The pains in the limbs and back, so pronounced at the outset, diminish, and at times yield to involuntary twitchings. In spite of the somnolence, the nights are still very much disturbed; the patients no longer complain of headache.

In addition to the accelerated respiration due to the fever, abundant râles are observed in the chest, with tolerable constancy, and the patient is troubled with a frequent dry cough, accompanied at times by a scanty mucous expectoration. Swallowing is rendered difficult on account of the dryness of the pharynx; there is a complete loss of appetite; the dejections are either scanty or a slight intestinal catarrh exists; and the contents of the intestine and bladder are passed involuntarily during the profound somnolence. There is now a very high degree of prostration; speech is indistinct, often stammering; the look is staring, expressionless; the impulse and sounds of the heart are feeble and indistinct. Meteorismus is rare. The sensitiveness of many such somnolent patients to firm pressure permits, at times, the erroneous conclusion of abdominal pain. On percussion and palpation the spleen is now found to be considerably swollen, and the enlarged lower portion may be at times found in the left hypochondrium. Probably every observer has noticed the peculiar odor of the patient at the acme of the disease; but I have never been able to define it. The urine is now scanty, opaque, highly colored, has an increased specific gravity, frequently contains albumen, a small amount of leucocytes, rarely blood, and, in the severe cases, escapes involuntarily or is retained.

It is easily comprehended that so serious a condition may rapidly end in death from exhaustion. In very severe cases death may occur during the first week, even in the first few days; the fatal event is most common, however, between the tenth and seventeenth days, rarely later. In all stages the coincident complications are to be added to the exhaustion as causes of death. It is particularly to be remembered that, even after the crisis has been entirely passed, not a few patients die from exhaustion or from a complication of the disease.

Fortunately a favorable result is the rule, and death the exception (on an average fifteen per cent.). In the favorable abortive cases a diminution of all the symptoms, associated with a critical defervescence, takes place at the end of the first or the beginning of the second week. Such is the febricula of the English authors. Otherwise the average diminution of the fever occurs from the tenth day to the end of the second week; though, in a further series of cases, it may occur during the early part of the third week, with a decided critical fall. The temperature, previously high, though often already somewhat lowered, falls suddenly to the normal, or even lower, during a single night, or within twenty-four hours, though equally often it may extend over a period of two days or longer. The skin becomes cooler and softer, perspires more or less freely; the pulse becomes decidedly slower, approaching the normal rate, and its quality improves; somnolence and coma often immediately disappear after a refreshing sleep, and the patients, as they have often enough expressed it to me, awake as from a long, heavy dream. The crisis is accompanied by the formation of sediments in the urine, an increase in its quantity, a disappearance of the albumen, and a normal amount of urea and chlorides, though these changes occur slowly. The eruption fades and disappears, the cough ceases with or without a mucous expectoration, the tongue cleans, the appetite improves, and within a few days convalescence is established, which terminates slowly in recovery, though much more quickly than in typhoid fever, so that the majority of patients are capable of returning to work within a month or less, unless serious complications retard the convalescence or cause a fatal termination

later. Even without such complications, and after the completion of the crisis, a slight increase of the evening temperature is not uncommon, just as the pulse remains increased for some time.

Gradually the appearance improves, the flabby skin becomes tense, the pulse fuller, the muscular pains—often grievous during convalescence—even cease, the hearing returns slowly, the nights become permanently comfortable ; appetite, digestion, and dejections become thoroughly normal, and thus the strength returns, though a long time yet is demanded for the body to completely recover its weight and the mind its strength. Loss of hair is not uncommon after an attack of typhus fever. True recurrences may take place, though less often than in typhoid fever, and Ebstein has described several such cases in the Breslau epidemic.

The most frequent complications are pneumonia, severe gastric and intestinal catarrhs, and bed-sores ; gangrene, parotitis, pleuritis, otitis, and venous thrombosis are rarer.

ANALYSIS OF INDIVIDUAL PHENOMENA.

Range of Temperature.

The results afforded by observations of temperature are spoken of first, since they unquestionably furnish the best measure of the severity and progress of the disease. Thermometrically, as in many other respects, typhus fever stands midway between typhoid and relapsing fevers. It is allied to the former by a rapidly increasing temperature, though increasing more rapidly and more decidedly ; further, by a distinct remittent character to the fever, and a more constant high range of temperature during the first ten to fourteen days. The main points of distinction are, that the temperature much more rapidly reaches or exceeds its average maximum of 105.8° ; that the duration of high fever is a much shorter one ; that early in the second week abnormal exacerbations or abatements precede the crisis, and that a distinct critical fall takes place usually in the second

half of the second week, at times later, which is not the case in typhoid fever.

The curve of typhus fever is analogous to that of relapsing fever at the outset, in that both rapidly attain a considerable height; in the latter this is greater, often beyond 107.6°; in addition, the fall occurs from the fifth to the seventh day, is sooner completed, is much more decided, and terminates in a temporary freedom from fever, followed later by the intense febrile relapse. As a whole, however, the range in typhus is much more like that of relapsing than of typhoid fever.

I add here, necessarily in brief, the result of my own analyses, particularly since the otherwise excellent statements of Wunderlich, Thierfelder, and Griesinger on this point seem to have been drawn from an insufficient number of observations, and in consequence are too narrow in many respects.

1. *The Onset and First Four Days.*—I have not been able to measure the temperature on the first day, either in the hospital or in my practice. Wunderlich[1] says: Even in the first evening the temperature reached from 104° to 104.9°," which agrees with the fact that I have found it as high as 106.4° in the evening of the second day, while in the evenings of the third and fourth days it may often be 105.8° and more, the morning temperature varying between 103.1° and 104°. This rapid and considerable increase, however, is in no way constant. Exceptionally, I find on the third day evening temperatures of 102.2°, 102.9°, and 103.6°, but this circumstance, however, must not be too favorably regarded as a means of prognosis, as the first case proved fatal on the sixteenth day.

2. *The last Three Days of the First Week.*—Wunderlich says of these, that after the temperature has reached its maximum on the fourth day, the turning-point is attained, and a gradual fall occurs. Excluding the cases of febricula with an early abatement, I find frequently an evening temperature of 103.1°, 104.9°, and even here in one-third of all the cases, evening rates of 104.9°–106.7°, but quite exceptionally those from 102.2° to 103.1°. So that, in general, it may be said that the evening tem-

[1] Das Verhalten der Eigenwärme in Krankheiten. Leipzig 1870. 2. Auflage, p. 330.

perature is somewhat less during the last three days of the first week, but that the difference is inconsiderable. Further, it is of no rare occurence (in one-third of the cases) that the evening rates are as high as those of the preceding days.

3. *Second Week, First Half.*—I include here only the first three days, as the tendency to the critical fall is often distinctly marked from the eleventh day onward. On the eighth, ninth, and tenth days I have exceptionally observed temperatures of 102.2° and less, which were of premonitory critical importance. Evening temperatures from 102.2° to 103.1° are uncommon; most frequent are those from 103.1° to 104.9° (nearly two-thirds), all the more resembling those of the first week, since for the remaining third a higher range, from 104.9° to 105.8°, is observed. Indeed, on these days I have most frequently observed the maximum temperature of the entire curve: 106.8°, 107.2°, 107.8°; at the same time with these high numbers there is a tendency to a slight lowering of the temperature during the first three days of the second week, so that the absolute mean is somewhat lower than that of the first week.

4. *Second Half of the Second Week, 11th to 14th Day.*—We have but a relatively small number of observations during this period, as we must exclude from the more numerous cases, soon to be considered, those in which variations occur preliminary to the crisis and the critical fall itself. Where no crisis takes place during this time, the evening temperature is somewhat lower than before, rarely below 102.2°; in nearly two-thirds of the cases, between 102.2° and 104°; in the remaining third between 104° and 105.8°, though much more often below 104.9° than above. I once found a record of 106.8°. Further, a decided daily tendency to a somewhat diminished evening temperature exists at this time.

5. *The Third Week.*—This is rarely of thermometric importance, as the abatement has now taken place or death has occurred. When the crisis occurs late in the week, a gradual fall precedes, or it rapidly follows a temperature of 104°–104.9°, or the disease disappears, exceptionally, with a gradual fall by lysis.

6. *Remissions.*—In general these are much less constant

than is usually considered; they vary often from one day to another, yet the usual variation from morning to evening is from 0.9° to 1.8°. But we may find in the same curve variations from 0.3° to 1.8°, and from 0.6° to 2.1°; small abatements which do not exceed 0.9° in the entire curve are rare. One much more frequently finds abrupt remissions varying from 0.9° to 2.7° (in one-fifth of the cases), or to 3.6°, or even to a daily difference of 4.5° (in one-tenth of the cases). The general range is therefore a moderate one, though more often decidedly than feebly remitting, with manifold variations in the same observation. Excluding the stage of abatement, I have only once seen a reversed range.

7. *Changes of Temperature preceding the Crisis.*—In one-tenth of the cases I have seen a decided rise of 3.6°, even of 4.5°, on the day before the abatement. A fall of temperature before the crisis is more common. On the day before the crisis a fall of 2.7°, 3.6°, even of 4.5° has occurred, so that a previous temperature of 102.2° and 100.4° has fallen to 99.5°, to rise again in the evening, then to yield permanently to the crisis. In other cases the abatement is progressive, and shows for several days a lower rate, morning and evening, than on the previous day. Apart from the cases in which there is a rise, and the more common ones in which there is a fall, before the crisis, there exists quite a number in which no special change precedes the fall in temperature, and the crisis takes place without being antici pated, as it were, by the thermometer, and then usually terminates rapidly.

8. *Critical Abatement.*—I have often called attention to the fact that the critical day is to be regarded as the most important period in the crisis, but not as the crisis; this is a process which may be terminated in twelve hours, though it generally requires one, two, three, even four days. Excluding the cases of febricula, where the abatement may occur at the end of the first or at the beginning of the second week, my observations show that the abatement occurs from the tenth to the twelfth day, inclusive, in two-fifths of the mildest or moderately severe cases; and in about the same number of cases, on the thirteenth and fourteenth days. It occurs much less frequently from the fifteenth to the eighteenth days.

The ratio of percentage is as follows ·—

Day.	Per cent.	
6th — 9th	= 12.3	71.4 per cent.
10th — 12th	= 41.9	
13th — 14th	= 29.2	
15th	= 8.2	16.6 "
After the 15th	= 8.4	

The crisis usually begins in the evening, and has made decided progress by the following morning; it is of rarer occurrence during the day. In one-third of the cases it was completed within twelve to twenty-four hours; in three-eighths of the cases, the relatively greatest number, it was ended in thirty-six hours. Forty-eight hours were required for the same number of cases as where twelve hours were required, while a duration of 60–84 hours and more was exceptional.

The following table gives the percentage:

Hours.	Per cent.	
12	= 21.0	33.5 per cent.
24	= 12.5	
36	= 37.5	66.5 "
48	= 21.0	
60 — 84	= 8.0	

The amount of the abatement is generally considerable; it was exceptionally found to be from 1.8° to 3.6°; on an average, however, it varied between 3.6° and 7.2°, less therefore than in relapsing fever, but fully equal to the true critical abatement of pneumonia.

1.8° — 3.6°	= 12.5 per cent.
3.6° — 5.4°	= 50.0 "
5.4° — 7.2°	= 37.5 "

Though for the most part critical cases terminate in recovery, I have seen one fatal case with an accidental complication of embolism of the lungs, and several where death occurred from collapse or complications, after the crisis was entirely finished.

The temperature falls either to the normal or below the same, to 98.6°, 97.7°, or even to 96.8°; I have never seen in typhus a fall to 95° and less, such as occurs in relapsing fever. On the

first evening after the normal point has been reached, the temperature often rises somewhat, to fall below the normal on the following morning. Where the convalescence is protracted and complications occur, isolated febrile conditions may be found after the crisis, though not usually marked; they may, however, be more decided. I have seen but few instances of a true lysis with a slow and gradual abatement during the third, fourth, and even fifth weeks. The critical termination forms the general rule in the favorable cases.

9. *Cases Terminating Fatally.*—Where this result is rapid, very high temperatures are observed. If death takes place during the second or third week, a high degree of fever is not uncommon; but this alone is no criterion, since fatal cases may occur with moderate fever, just as well as recovery with constant high fever.

Wunderlich states that the rise in temperature during the agony varies from 2.7° to 6.4°, the average being 3.2°. With the exception of a single case, in which a fatal pulmonary embolism occurred during convalescence with a temperature of 98.7°, my own experience confirms Wunderlich's statement. The average temperature at the time of death was from 104° to 104.9°, in Wunderlich's estimate from 107.6° to 109.4°. The mean increase preceding the agony I found to be 2.7°.

Modifications of the Circulation.

The pulse, on the whole, follows the range of temperature, rapidly reaching a considerable height (120–130), and rapidly falling with the defervescence, so that when the temperature is below the normal the pulse may be at 84.

A complication is suggested when the pulse becomes accelerated after the fall of temperature, particularly when the patient is in bed and quiet; such an acceleration may be far more pronounced than the rise of the temperature, whereas the reverse occurs before the decrease of temperature.

It is difficult to explain why the almost constant duplication of the pulse in typhoid fever so exceptionally occurs in typhus, even at its acme. It seems probable that it is connected with the relatively more decided cardiac weakness, which also begins

much earlier; in fact, not a few patients die from fatty degeneration of the heart during the second week, that is, at the acme of the disease, previous to the defervescence.

When the sounds of the heart, particularly the first, are feeble, the pulse is very rapid, small, almost thready, and the strongest stimulants are necessary to bridge over this dangerous condition. From an anatomical point of view this effect of acute fatty degeneration of the heart in fever is not remarkable, since similar alterations of the liver and kidneys occur, though thereby merely slight disturbances of function result, and gradually a complete return to the normal condition takes place. The heart's action being enfeebled, blood is forced into the arteries under a reduced pressure; it consequently returns more slowly and with greater difficulty to the heart through the veins; hence the frequent lividity of the face, hands, and feet, and, in severe cases, the formation of clots, which may lead to thrombosis of the great veins of the thigh, with swelling of the entire leg. As a rare result, we may have, from stoppage of an artery, gangrene, dry or moist, of a foot, leg, fingers, or hand, under which circumstances it sometimes happens that, besides local clot-formation, small clots may form in the feebly acting heart, and thence be transported as emboli to the larger arteries, obstructing them and producing gangrene.

The absence of pulsation in the radial artery, often existing for days, and to which Stokes called attention, is thus explained by the obstruction of middle-sized arteries, which have anastomoses, however, of sufficient size to permit the establishment of a compensatory circulation.

Alterations of the Skin.

I have already described the chief characteristics of the eruption; but I must again protest against its possessing any specific character. Both in Zurich and Breslau, I have seen a series of cases of typhoid fever in which the spots, though not very numerous, were scattered over the extremities. These spots, furthermore, do not entirely disappear on pressure in the later

stages of typhoid fever. Hence, there is no essential distinction in this particular. The following rules, however, are to be borne in mind: The eruption of typhus fever is much more constant, in general much larger and more extended, is more likely to occur on the extremities and face, is of shorter duration, and is more prone to become petechial than in typhoid fever. In a word, in typhoid the eruption is a secondary matter; in typhus it is a much more prominent affair, though by no means the main feature, as in the true infectious exanthemata—measles, scarlet fever, and small-pox.

In typhus fever the eruption is a very important event in the infection, being present upon the body at the time when the entire organism is very thoroughly diseased; while in the exanthemata the disease reaches its acme with the appearance of the eruption, or at that time the intensity of the fever may even diminish.

But little weight is to be attached to the more or less flat or papular character of the spots. It is an interesting fact that, while the exanthematous diseases generally pursue an abortive course, when the eruption is wanting, the rare cases of typhus fever, which have no eruption, have proved, in my experience, to be very serious, in several instances terminating fatally.

The more or less distinct occurrence of the eruption among children must be subject to variations. Griesinger regards it as slight, often to be found as a mere trace. I, on the contrary, have shown several children to the students, where the extent of the eruption was as great as in measles. The general statement is made that the rash appears on an average from the fourth to the sixth day. In the Breslau epidemic I saw it commencing particularly often on the sixth and seventh days. Where only a slight degree of hemorrhage occurs from individual spots, the eruption disappears with or immediately after the deferves cence; if the transformation into petechiæ is more extended and marked (true petechial typhus), these petechiæ persist for many days after the crisis, unless death occurs, which is very frequent when the hemorrhagic character of the spots is marked. In such cases small ecchymoses are usually found in the mucous membranes and subserous areolar tissue. I cannot by any

means accept the statement made by Griesinger, that the milder the case in general, the less the rash; the more abundant the rash, the more severe the disease (op. cit. p. 135). I have not been able to observe such a constant correlation between these two, any more than between the rash and the severity of the fever.

There may be, independently of the eruption, other changes in the skin, such as large or small hemorrhages, ecchymotic streaks or blotches, generally due to pressure.

I have never seen erysipelas in my wards, though it has frequently been observed in the typhus wards of All-Saints' Hospital, and I agree with Griesinger in considering it as due to the influence of the hospital. Miliaria occurs often after profuse sweating, especially at the time of the crisis. On the other hand, I have found herpes of the lips to be very exceptional, though, according to Barrallier, it was of relatively frequent occurrence among the French patients during the Crimean War.

Desquamation is not rare after the eruption, but is generally trivial.

Disturbances of the Digestive System.

The affection of the digestive organs is for the most part influenced by the severity of the fever, and consists rather of disturbances of function, or of catarrhal conditions of the pharynx, stomach, and intestinal canal. Severe diphtheritic complications in the pharynx, at times of a destructive, almost gangrenous character, occur sometimes in typhus wards, particularly where many cases are crowded together in confined spaces; they are relatively rare, however, in well-ventilated wards, where typhus patients are mixed with others. Otherwise difficulty in swallowing is either the result of extreme dryness, or, exceptionally, may be spasmodic, or due to paralysis.

Diarrhœa is absent in many epidemics, in others frequent, as in Breslau, and among the Irish emigrants in North America, and usually occurs early in the disease, ceasing after a few days or at the period of defervescence. The stools are usually not so watery as in typhoid fever, though they may occasionally very

closely resemble them. When there is no diarrhœa, there may be a decided tendency to constipation among some, while among others the bowels are regular. Involuntary dejections occur only in very severe cases. Such generally prove fatal. In contradistinction to typhoid fever, meteorism and pain in the ileo-cæcal region are generally absent.

Diphtheritic inflammation of the colon may occur as a rare secondary disease. It seemed to me very remarkable that Griesinger should state that the splenic enlargement is absent in many epidemics, as found, for instance by Oesterlen, in the epidemic at Dorpat. An acute splenic enlargement may be regarded as the rule. It is found in about three-fourths of the autopsies, and is associated with a marked degree of softening, etc. ; the spleen has even been found ruptured (Horn), though this is of very rare occurrence. The absence of enlargement in one-fourth of the cases, even when death occurs before the end of the second week, or during the beginning of the third, proves that this lesion is not so essential to typhus as to typhoid fever. But that the splenic enlargement should be absent in entire epidemics is, to say the least, very remarkable.

Disturbances of the Respiratory System.

I have found almost constantly affections of the organs of respiration similar to those occurring in typhoid fever, though less in degree. Bronchitis usually occurs during the first week ; the cough is slight, there is little or no expectoration, no difficulty of respiration, and one hears merely isolated, rather sibilant râles. During the second week the bronchitis may become diffused, terminate in bronchiolitis, connected with atelectasis, and the condensation, without infiltration, of larger portions of the lungs. In such cases the symptoms are very decided, and may even predominate, so that one might speak of a bronchial typhus. Indeed I have seen cases of extensive purulent bronchitis where the eruption was absent, and where the diagnosis was established merely by the range of temperature and the increasing enlargement of the spleen. A considerable number of the fatal cases owe their unfavorable course to a bronchiolitis, broncho-pneumonia, or

diffuse pneumonia, while extensive pleurisy and gangrene of the lungs are rare; tuberculosis rarely complicates typhus fever. Of laryngeal affections I have seen only, though repeatedly, simple catarrh, accompanied by hoarseness. In many epidemics a diphtheritic croup has often been observed. Ulceration of the larynx is rare, decidedly more so than in typhoid fever.

Alterations of the Urine.

The changes in the urine are like those of the other forms of continued fevers; albuminuria also is equally common. The formation of copious sediments at the period of defervescence is not unusual, though not constant. After the defervescence the albumen often disappears. Suddenly, during the height of the fever, Jenner, Finger, and Griesinger have often seen a copious flow of normally colored, even pale urine. In very severe cases the urine escapes involuntarily or is retained. I have never observed uræmia, though I have paid due attention to this point. During the convalescence of typhoid fever there often occurs an irritation of the neck of the bladder, with frequent painful evacuations of urine, in which is a muco-purulent sediment; but I have rarely seen such a condition in typhus fever.

Affections of the Nervous System.

In febricula and in the milder cases the nervous system is but slightly affected; but on the average typhus produces earlier, and, more decidedly than typhoid fever, great prostration of the strength, subjective sensations of extreme debility, indistinct speech, twitchings of the limbs, and protruded tongue, together with every transition from dulness to drowsiness, sleep, stupor, and coma. Delirium is usually of a mild type, only at times violent and wild, and occurs during the first few days in severe cases, and is then constant; generally, however, it first occurs in the night, then more or less often during the day, but finally the comatose and other evidences of prostration, the position in bed,

the collapsed visage, the dull, lack-lustre look, the pale wretched appearance, reach their highest degree when collapse ushers in death. Curiously contrasted with the somnolent condition, especially during the second week, and by no means rare, is the decided hyperæsthesia of the entire surface of the body. The headache is as marked as in typhoid fever, and ceases after a few days, while the pains in the back and limbs during the first few days of the disease are much more pronounced and severe than in typhoid fever. Griesinger rightly attributes the deafness to catarrh of the outer and middle ear (perhaps rather the latter). Spasms and convulsions are rare, though they are apparently more common in many epidemics, and may be caused by uræmia where nephritis exists as a complication.

COMPLICATIONS AND SECONDARY PROCESSES.

These are manifold, and vary according to the epidemic. Whereas I have seen jaundice exceptionally and then slight in other epidemics, it seems to have been frequent and so intense that Griesinger was thereby reminded of bilious typhoid fever. On several occasions I have seen enlargement and suppuration of the parotid gland, and I consider this complication as a very dangerous one; nevertheless I have often seen a successful termination, since I have treated all the abscesses and suppuration processes in my wards according to the method of Lister. Parotitis occurs early in many epidemics, likewise often, even in twenty per cent. of the cases (Schilling, New York, 1852). In the Breslau hospital I have often seen consecutive furunculosis and multiple abscesses, and, as I have already mentioned, gangrene occurred during this epidemic in different parts of the body, not only as the ordinary gangrenous bed-sore, but also as dry gangrene of the lower extremities, and in one of my cases as gangrene of the lungs. Severe secondary diseases are rare in general; I have never met with sudden death at the acme of the disease; and but once only after the defervescence, then from pulmonary embolism. Local or general paralysis, otorrhœa, and mental feebleness are of rare occurrence.

DURATION AND PROGRESS.

A few remarks are now in place concerning the duration of the cases ending favorably, and the mortality. As we have already seen, febricula may end in permanent improvement at the close of the first or at the beginning of the second week. The duration of the milder cases averages from one and a half to two weeks, most often from two to three weeks, though it may be prolonged to four, five, and six weeks by complications and relapses. In general, convalescence may be regarded as demanding an equal amount of time as the disease, so that an interval of four to six weeks is required before the patient is able to resume work. In the Breslau epidemic the mean number of days spent in the hospital was 32.15, and varied generally between four and five weeks. The patients recovering from typhus are usually less emaciated than typhoid patients in a similar situation; hence the ability to return sooner to work. I have seen, exceptionally, the duration of the disease prolonged to five or six weeks, not merely by complications but also by protracted convalescence of a slight febrile character. Women usually remained longer in the hospital than men, the average rate being between 31.69 and 33 days. The influence of age was a decided one. For the first five years the average number of days in the hospital was 44.7; from five to ten years, 31; from ten to forty years, between 35 and 38 days; after the age of forty the average was below four weeks. The abortive cases, 11 per cent., are excluded from the series. While the epidemic was increasing, and when at its height, the mean duration was longer than during the close.

MORTALITY.

In very severe cases, and then exceptionally, I have seen death occurring on the third day, and cases are known where death has taken place even earlier; otherwise death before the end of the first week is exceptional. It generally occurs during the second or third week. The mortality varied extremely in the different epidemics; in the Valais epidemic of 1839 I reckoned it at 6 to 7 per cent.; a still lower rate of mortality exists in certain

epidemics. According to Griesinger the mean mortality varies between 15 and 20 per cent. During the Breslau epidemic of 1868–69 it was 15.13 per cent., rather more than one-seventh; the greater number was composed of males, even making allowance for the fact that males are more often attacked than females. Here, too, age was of great importance. From childhood to the fifteenth year, inclusive, representing 15.2 per cent. of all the cases, we find a mortality of only 2.7 per cent. of the total. From fifteen to twenty years the number of cases was 16.1 per cent., the mortality 3.16 per cent. It is thus to be seen that the mortality in childhood and early youth was relatively small. From twenty to thirty years the number of cases formed 22.8 per cent., the mortality 15 per cent; between thirty and forty years, 23 per cent. of the patients, 26 per cent. of the deaths. The mortality now exceeds the percentage of cases. Between forty and fifty years, the number of the cases was 13.4 per cent., the mortality 24.1 per cent.; while between fifty and sixty years, with only 7.4 per cent. of the cases, we find 20 per cent. of the total death-rate; the disease therefore became the more fatal with increasing age. I refer you to Griesinger for a statement of the high degree of mortality in certain epidemics, from 30 to 50 per cent. and more, and will simply call attention to the following extract from Murchison, who has proven for typhus fever what I have shown to be true of typhoid fever and pneumonia, that different years furnish marked variations in the death-rate, even in the same hospital and with the same treatment. According to Murchison, during fourteen and a half years at the London Fever Hospital, the mortality from typhus was 20.89 per cent., and excluding the cases dying within the first twenty-four hours, it was 19.56 per cent.; in 1851 it fell to 8.8; in 1850 it rose to 60 per cent. Out of 18,292 cases, from the different hospitals of London, Glasgow, and Edinburgh, there were 3,525 deaths, a mortality of 18.78 per cent.

PATHOLOGICAL ANATOMY.

When the patients die early in the disease their bodies are usually well nourished, while from the end of the second week

onward they are emaciated. Post-mortem rigidity is usually of short duration, and decomposition is rapid. Bed-sores are observed in relatively few cases; dry gangrene of the extremities is also rare. The muscles are usually brownish-red and dry, presenting an infiltration of fine granules in the primitive fibres when death has taken place in the third or fourth week. The mucous membrane of the digestive tract shows no characteristic appearances, with the exception of the evidence of a slight degree of catarrh. Though in this respect there is a marked difference from typhoid fever, it is, nevertheless, not unusual to find the glands of the small intestine moderately swollen; indeed, in rare cases, and there were such in the Breslau epidemic, the solitary glands, as well as Peyer's patches, were the seat of small isolated superficial ulcers, usually, too, in the vicinity of the ileo-cæcal valve. It is likewise not unusual to observe a swelling of the mesenteric glands, though without the medullary infiltration.

Enlargement of the spleen, with decided softening, is the rule, though not without exceptions, since even among those who died up to the beginning of the third week, it was wanting in more than one-fourth of the cases. The softening is particularly marked during the first and second weeks, in the one series of cases, there being no distinction of structure; in the other, the Malpighian follicles are distinct and enlarged. Extravasations of blood into the tissue of the spleen are not uncommon, though more common when death occurs late. The liver shows nothing characteristic, at times only it is moderately swollen; but disseminated patches of fatty degeneration, with obscurity of structure and outline, are so common as to be regarded as belonging, to a certain extent, to the course of the disease. The same is true of the kidneys, whose cortex is early swollen, opaque, and more or less fatty, according to the duration of the disease. This tendency to cloudy swelling and granular fatty degeneration, which we have already recognized in the liver, muscles, and kidneys, also occurs in the heart, often after a protracted duration of the disease; its walls are then flaccid, of a brownish-yellow color, and with the microscope the fat granules are distinctly recognized. There is usually a considerable amount of serum in the pericardium. The blood found in the heart and larger veins usu-

ally forms a black, pultaceous, soft clot, in which there is but little distinctly coagulated fibrine.

Thrombi are often found firmly adherent to the walls of the large veins of the thigh, and rarely as emboli in the arteries of the extremities. Despite the evident participation of the brain and nervous system in the disease, they present nothing characteristic anatomically ; early there is injection of the membranes and cerebral substance, later, rather a diminished amount of blood, and an accumulation of serum between the membranes and in the ventricles. Ecchymoses are not uncommon in the serous and mucous membranes. Secondary diphtheritis of the pharynx and upper part of the respiratory tract, also ulcers of the larynx, are among the rarer complications. The mucous membrane of the trachea and bronchi is very often injected and covered with mucus, and anatomical evidence is found of inflammation of the larger and smallest bronchi, isolated or diffused, their contents varying from mucus to a thick pus. Patches of atelectasis are found as a result of the bronchiolitis and broncho-pneumonia, such being in part inflamed and infiltrated, or we find diffused condensed portions without infiltration ; true pneumonia may likewise be present as a diffused infiltration of one or more lobes.

In individual cases these inflamed portions may be undergoing a gangrenous destruction. When pleurisy is present we usually find the fibrinous, rarely the exudative form, and then exudation is scanty. The bronchial glands are swollen at times.

There are, therefore, no characteristic and pathognomonic changes in typhus fever. The peculiar typhus material accepted by many authors I have never been able to find. Anatomically, we have rather to deal with the results of an extremely febrile infection, with nutritive disturbances, a tendency to fatty degeneration in many organs, a frequent enlargement of the spleen, and a tolerably constant and complete affection of the respiratory organs. There is no organ, however, which is the peculiar and principal place of deposition for the disease.

DIAGNOSIS.

Although there is no distinctive anatomical characteristic of typhus fever, the clinical features are in general very striking.

The eruption is distinguished by its profusion and extent over the trunk and extremities, and might be mistaken for that of measles were it not that an intensely febrile and distinctly typhous affection precedes its appearance some four or five days. Further, it is of longer duration in general, is not papular, and shows an early tendency to the escape of blood-coloring matter, so that the spots no longer fade on pressure. The rapid enlargement of the spleen is also characteristic, and the bronchial catarrh is very different from that of measles, where a troublesome cough is of early occurrence; while the bronchitis of typhus fever is at the outset of trifling inconvenience. The early and decided prostration, with the tendency to drowsiness and stupor, is likewise characteristic. Where the diarrhœa is marked, and the course prolonged, this disease may be confounded with typhoid fever. The diagnosis of typhus fever is usually confirmed by the abundance and extent of the eruption, by the more rapid increase of the fever, the speedier occurrence of its acme, and the decided tendency to a critical defervescence in the last days of the second week, conditions which are absent in typhoid fever. Then, too, the ileo-cæcal pain, the meteorism, and the peculiar liquid stools are characteristic of typhoid fever. Although exceptional cases with a protracted course may occur, cases in which a certain resemblance to both diseases may exist, yet a decided and fundamental difference must be still insisted upon, one which makes two separate diseases of typhus and typhoid fever.

PROGNOSIS.

According to what has been hitherto said, the prognosis of typhus fever may thus be stated: About six-sevenths of the cases are likely to recover. This statement of course must vary for individual epidemics occurring at different periods, as in the favorable ones scarcely a tenth, twelfth, or thirteenth of the cases die, while in the severe epidemics from one-fifth to one-half die. Even a still greater number of the cases may die; luckily such severe epidemics are by far more rare than the mild ones. I attach great weight to the mean rate of mortality—fifteen per cent.—because this is the result of numerous comparisons, and rather

curiously corresponds with the mean for all my observations in pneumonia and typhoid fever. All the competent English observers agree with my results obtained in the Breslau epidemic, where the prognosis was found to be decidedly favorable in childhood and early youth, relatively favorable up to the age of thirty years, but becoming progressively more unfavorable afterwards from decade to decade; the mean mortality is exceeded between thirty and forty years (according to my statistics being more than one-fourth), while it becomes almost one-half between fifty and sixty years. Older people generally die from pulmonary complications. The strong and healthy overcome the disease better than the sickly and feeble. A regular course, even with high fever at the outset, is not unfavorable. Severe affections of the nervous system, delirium in the first few days, alternating with stupor, a dark-red eruption, petechiæ, a small irregular pulse, involuntary evacuations, or their retention, are unfavorable symptoms when observed early in the disease. The most serious of the different complications are broncho-pneumonia, diffuse pneumonia, and parotitis. Although unexpected intestinal symptoms of evil prognosis are not to be feared in typhus fever, such as intestinal hemorrhage and perforation, yet it must be borne in mind, and remembered in giving the prognosis, that cases which are apparently following a favorable course may rapidly turn out badly, the reverse being also true that patients who are very much reduced may still unexpectedly recover. Both conditions are exceptional, however, and the experienced physician will generally know how to discriminate, even early, between those cases in which the prognosis is grave and those in which it is favorable.

TREATMENT.

First of all, preventive measures are of importance. Medical skill is unable to prevent the first importation. Much can be accomplished by improved hygienic conditions in those regions and cities infected with typhus, such as introducing the necessary hygienic improvements in those parts of the city where the poor, dirty, and neglected are aggregated together; overcrowding,

foul air, dampness, etc., deserving special attention. This is important in prisons also, where, since the improvement in hygiene, typhus and dysentery have become very much diminished. It is also of consequence to improve the quality of the drinking-water by good aqueducts. It is of the utmost probability that in those places where the disease is endemic the germs of typhus readily accumulate in the stagnant ground-water, and thence readily pass into the air and drinking-water. Posen is one of those places where typhus is of frequent occurrence, and this disease seems to have become much more rare there since the improvement in the distribution of water. Military hygiene is of no less importance. During the Crimean war the English army instituted a much more vigorous police inspection of the camp than the French, and suffered much less from typhus.

As in all epidemics of contagious diseases, the first cases are to be watched with especial care, and to be isolated, if possible, by placing the patients, previously washed and cleansed, in separate hospital wards; while their clothes and effects are to be disinfected by hot air and by sulphurous acid, or the fumes of sulphur developed from the combustion of brimstone.

It is advisable, when possible, to close the infected buildings, to destroy the parasitic germs in them by means of prolonged fumigation with sulphur, to see that they remain open for some time for the purposes of thorough ventilation, and then to whitewash them. Before the patients leave the hospital they are to be bathed, and their effects to be again disinfected. If the patients must be treated at home—as is the case with the wealthy—useless visits and contagion should be prevented by putting a placard announcing the presence of typhus fever upon the outside of the house, and not, as usually happens, inside.

In the late epidemic I found it to be an excellent plan, even during the severest cold of winter, to keep the windows open during part of the day and night; the patients bear it well during the fever, though they are very sensitive to cold after the defervescence. Wearing apparel and bedclothes are to be disinfected by heat and sulphur fumes, the stuffing of mattresses and other cheap articles are to be burned. Chlorine is a good

deodorizer, but is much less likely to destroy the infectious germs than the fumes of sulphur and sulphurous acid. All the rooms, both chambers and others, are to be first thoroughly fumigated with sulphur and then to be scrupulously ventilated. When the epidemics occur during the summer, treatment in isolated tents and barracks, as in camps, is to be preferred to that in hospitals; when typhus fever prevails among soldiers they should not be quartered in the houses of citizens. Absolute cleanliness is to be insisted upon, both with regard to the bed, the body, and the excretions of the patient.

The treatment of the patient is at the best expectant, as in typhoid fever and acute diseases generally, and once more I insist upon the most careful and thorough ventilation, for cold is much less to be feared than bad air. Quiet is to be maintained. As the nursing is exhaustive, experienced nurses should be obtained. Cool drinks in abundance, water, lemonade, carbonic acid water, particularly that which has been made with distilled water, and every three hours I give milk, broth, or small quantities of weak soup. Cold sponging is rather pleasant than useful. Cold baths at about 65°Fahr. may be repeated day and night as often as the temperature rises above 102.2° Fahr.; these are not only well borne, but meet with no opposition from the patient as soon as a few have been taken.

Great relief is thus obtained in the severe cases with high fever, and a more favorable result is induced; the patients sleep better, and the thoracic and intestinal symptoms are usually not aggravated. At the same time, the question of the general utility of cold baths in typhus fever cannot be decided, owing to insufficient material.

It seems probable, from the decidedly favorable results of cold baths in typhoid fever, that this method will become nniversally adopted in typhus fever. Cold baths or bags of ice applied to the head are useful in headache. Drugs, as such, are unnecessary, but I give them chiefly to satisfy the patients and their friends. I am in the habit of prescribing the dilute phosphoric acid, from a drachm to a drachm and a half, mixed in four ounces of water, and one ounce of raspberry syrup, of which mixture a tablespoonful is to be taken every two hours.

Cold water injections readily relieve constipation. Where the strength rapidly fails, stimulants and excitants are to be earlier employed, and more freely than in typhoid fever. Best of all is good old wine, to be given three or four times daily in doses of one or several tablespoonfuls. Ethereal mixtures, ammonium carbonate, water of ammonia with alcohol and oil of anise, camphor, musk, in substance or tincture, are to be used as in typhoid fever. Where there is extreme restlessness, a warm bath often proves efficacious, either alone or followed by a cold douche.

Large doses of quinine, fifteen to thirty grains, are to be employed only when the fever is very intense, and cold baths cannot be used. Where the thoracic symptoms are marked, an infusion of ipecacuanha with water of ammonia, alcohol, and oil of anise may be given. Small doses of opium or morphine may be prescribed for the exhausting wakefulness during convalescence. When the improvement has fairly begun, a more nourishing diet should gradually be attained, but care should be taken against any loading of the stomach or error in diet.

It must also be seen to that the patients do not return to their employment or work before their strength is thoroughly restored.

CHOLERA.

Cholera is a disease which is in lighter form sporadic, in graver specific, and usually epidemic. It is characterized—after frequent prodromal diarrhœa—by the discharge from the stomach and bowels of a copious, colorless, rice-water fluid; by severe cramps, anuria, coldness and subsequent restoration of heat, with either a swiftly fatal termination during the attack or in the algid state, or a speedy recovery after previous albuminuria. When the disease is somewhat more protracted in duration, it frequently assumes the typhoid form, which may then prove fatal, or may lead to recovery through a tedious convalescence.

It is of the highest importance to describe separately the sporadic form, the Cholera nostras, which occurs everywhere and at all times, and the epidemic, so-called Asiatic, Indian, or Oriental Cholera. The two affections are certainly not identical, though they have much in common. We shall indeed see, later, that the cholerine prevalent during an outbreak of epidemic cholera is not identical with sporadic cholera, though the resemblance between the two is often so striking, that they may not always be differentiated by the symptoms of each.

I. CHOLERA NOSTRAS, EUROPÆA.

(Cholera Morbus.)

SHORT HISTORICAL COMMENTS.

We prefer the term cholera nostras, or Europæa, to that of sporadic cholera, because this disease, for centuries so well known in Europe, may occur as an epidemic, while the Indian cholera, on the other hand—this dread though long since accli-

mated guest amongst us—occurs often, fortunately, in only sporadic form in places where it has been carried. The term cholerine, moreover, which is often used to denote cholera nostras, has nothing characteristic in it, as there is a perfectly similar form of Indian cholera, which, when it occurs as an epidemic, cannot always be separated from it. Among the older writers, we often find cholera nostras called Passio Cholerica or Cholerrhagia. The old name cholera itself shows that this affection should not be mistaken for the Asiatic disease; for, etymologically, cholera means bile-flow, and it is just the bile which is absent in the colorless rice-water stools of Asiatic cholera. The form of the disease now under consideration is said (Ozanam[1]) to have been mentioned in the Old Testament in Zechariah and Ecclesiastes. Hippocrates, Celsus, and Cælius Aureliamus speak of it, and Aretæus describes it excellently, especially the manner and nature of the discharges from the stomach and bowels, as well as its repeated occurrence in summer and its greater frequency among young people and children. Diogenes the cynic is said to have died of it after a fit of indigestion produced by eating raw cow's feet—a melancholy end to the philosophical dweller in a tub. It is only as late as the sixteenth century, however, that we begin to find mention of epidemics of this disease. An epidemic in the year 1548, described by Forestus[2] deserves particular mention. Riverius, also, mentions a cholera epidemic as having prevailed in 1645, previous to the plague. Sydenham notices the London epidemic in 1669–1672. But other diseases, characterized by constipation and severe abdominal pains, seem to have been confounded here with cholera. It seems to me, indeed, that several of the diseases considered as cholera epidemics in the eighteenth century, as well as the pestilence described under the name *Trousse-galant*, do not belong to cholera nostras, but rather to forms of epidemic colic with vomiting, and I have often suspected that the diseases showing so much resemblance to lead colic may have been due to the habit, in former times, of sophisticating so many drinks

[1] *Ozanam*, Histoire médicale des maladies épidémiques. Paris et Lyon, 1825.

[2] Obs. med. XVIII.

with sugar of lead. Our more recent literature, finally, contains numerous references to epidemics of cholera infantum, with one of which, in the Franche-Comté, in the year 1852, I am well acquainted.

European cholera consists of suddenly occurring violent vomiting and diarrhœa, with great distress and anxiety. These symptoms cease quickly, as a rule, but they may run on to a fatal termination in some cases, with manifestations closely similar to the Indian disease.

ETIOLOGY.

Cholera nostras, as a rule, is a disease which belongs to the last part of the summer. It often begins in July, but it is by far the most frequent in August and September. Now it is observed in only isolated cases, again there is a greater number of cases in a short time, and again it occurs as an epidemic of wide extent. Hot seasons show such cases oftener than cool, but what especially predisposes to it is changeable weather: hot weather with dampness alternating with cooler weather, and cool nights after excessively warm days. It is more frequent and more fatal in the southern countries of Europe than in the northern or temperate climates. It may originate alone, therefore, from colds; but as a rule it is more closely connected with imprudences in diet and disturbances of digestion. A most frequent cause is the ingestion of drink too abundantly or too frequently—especially of bad drinking-water—after intense or long-continued thirst. Overloading the stomach with all kinds of food, especially with large quantities of indigestible, succulent vegetables, unripe fruits, fermented liquors of bad quality, meat in commencing putrefaction, or the ingestion of cold fluids in great abundance during perspiration or violent mental disturbances, when the stomach is only moderately filled—all act as predisposing causes.

When we remember that fluid and solid ingesta act far more injuriously according to quality than quantity, the question arises whether there is not a septic element at work as a causative agent of great importance, and whether the chief difference

between cholera nostras and Indica does not consist in the fact that our cholera depends more upon the parasites of common decomposition or putrefaction, while the Indian form is due to a foreign, specific, originally imported, but now acclimated germ, which always produces the same specific form of the disease. That cholera nostras does stand in connection with the products of decomposition and septic elements, and that even putrid exhalations may excite it, is proven by the well-known and often-quoted example of Searle,[1] who relates that after an alley, filled with mud and refuse, had been cleaned and the exceedingly offensive exhalations had filled the garden, twenty out of thirty children in a London school took sick with cholera nostras, and two of the children died. It is a pertinent question here, however, whether soil infiltration and infection of the drinking-water did not contribute to produce the disease. The drinking-water was also accused in a remarkable epidemic observed during the winter season by Levier[2] in Berne. Youth and middle age and the male sex are most disposed to the disease, though it may occur at all periods of life. Weak stomachs and frequent intestinal catarrhs increase the predisposition.

SYMPTOMATOLOGY.

The inception of the disease is often sudden, especially in the night, yet disturbances of digestion may pre-exist for one or two days. There is loss of appetite, hebetude, malaise, even pain in the stomach, with general discomfort and feeling of anxiety. Soon now there is nausea, eructation, and violent vomiting. At first the food in the stomach is ejected, then the vomited matter is a watery mucus, colored yellow, green, or brown, with more or less bile, sometimes of burning, of sour or bitter taste. Often diarrhœa occurs first, and remains alone without any vomiting; then follow violent pains in the bowels and copious alvine discharges, at first of the contents of the intestine, afterwards of a fluid of dark, rather brownish color. The vomiting and the

[1] London Medical Gazette, 1829. Vol. IV. p. 375.

[2] Schweiz. Zeitschr. f. Heilk. III. 1. 1864. p. 140.

diarrhœa may follow each other swiftly and violently; they may alternate with each other or exist simultaneously. The least quantity of fluid ingested causes vomiting. The number of the discharges is at first from three to five or even as many as ten or twelve in the first hour; they may, however, be fewer, or in the worse cases more numerous. The whole abdomen is very sensitive to pressure; and colic pains occur spontaneously from time to time. Many patients complain of a most tormenting præcordial anxiety. Some are tortured by more or less violent efforts of hiccough. Immediately after the discharges there is some slight relief; but the tongue is coated, the thirst intense, the taste bad. The general condition suffers from the frequently repeated, numerous, and copious discharges; the face becomes pale, the features express weakness and suffering, the pulse is quickened and weak. Cramps in the calves, the feet, and muscles of the abdomen torture the patient extremely. In the worse cases the debility rapidly increases, the pulse becomes frequent, small, and thready, the voice weak and almost inarticulate, the breathing quick, the skin cold and clammy; the secretion of urine is scant, or even suppressed.

Head symptoms, even headache, are lacking. Should the disease take on a bad turn, there is great anxiety and depression. The almost uninterrupted discharges are finally involuntary, the cramps scarcely cease entirely, and are occasionally attended with convulsions, the features fall, the eyes sink, the cheeks become hollow, and thus death follows by speedy collapse. Should the disease take a favorable turn, the discharges diminish quickly in violence and frequency. The desire to vomit gives way, and only at longer and longer intervals is there a fluid stool. Not unfrequently a profuse sweat breaks out, and the patient enjoys some hours of refreshing sleep. But there is still great weakness for several days, and it is only slowly that the former condition of health is restored. Any real fever shows itself only exceptionally and transitorily, during the whole course of the disease. Colorless rice-water discharges from the stomach and bowels belong to the rarer manifestations. I have seen such discharges, however, most positively, in sporadic cases of cholera outside of the period of any epidemic. The

stomach and intestines remain for a long time very impressionable, and disturbances of digestion and diarrhœa occur on the slightest provocation.

The so-called cholera infantum has the same symptomatology, modified only by the difference of age.

PATHOLOGICAL ANATOMY.

Nothing at all characteristic can be found in adults in cases of unfortunate termination. The mucous membrane of the stomach and upper part of the intestinal canal is reddened, it is true, but there is no softening, no swelling, no thinning of this membrane. It is only in very small children that we observe almost constantly softening of the gastric mucous membrane, so that Rilliet and Barthez consider this stomach softening of small children as characteristic of cholera infantum; yet they, too, declare that the mucous membrane of the stomach alone, or that of the small intestine, may be softened with or without greater development of the follicles, and that such softening and follicular swelling, on the other hand, may be entirely absent.

DIAGNOSIS.

This disease may be mistaken for simple common indigestion; yet in this case we have, on the one hand, a definite cause as evidence, and the diarrhœa, on the other, is much less frequent. Cholerine often shows a great resemblance to poisoning; yet here there is burning pain in the œsophagus and stomach before vomiting, a symptom always excited by acrid poisons; diarrhœa is lacking, or but slight, and only follows after a considerable interval. Examination of the mouth reveals usually reddened surfaces or ulcers. Cholera nostras differs from Asiatic cholera in the absence of the prodromal stage, especially of the premonitory diarrhœa, in the color of the stools, in its rapid and far more favorable course, in the absence of a real epidemic of the oriental disease. Individual cases may, however, present the most deceptive resemblance to Asiatic cholera. These cases can

only be cleared up by further time, which proves the existence or absence of an epidemic.

PROGNOSIS.

The prognosis, as a rule, is favorable, for the mortality of this disease, as stated, is slight. It is more grave in infancy, of course, than at any other period of life; likewise in feeble, reduced persons and in old age. Very violent and profuse discharges, especially the rice-water involuntary discharges, rapid collapse, coldness of the skin, very small and feeble pulse, intense cramps, profound alterations of the features belong to the unfavorable symptoms.

TREATMENT.

The discharges from the stomach and bowels in individuals otherwise in good condition should rather be encouraged by tepid drinks, chamomile or linden-flower tea. As soon as the vomiting brings up only fluids, without food remnants, though mingled with bile and attended with pain and great effort, the attempt should be made to arrest it as soon as possible. Ice acts excellently here, administered in pieces of the size of a hazel nut or bean every five to ten minutes, or much oftener. Cool drinks containing carbonic acid gas, artificial seltzer, and soda-water, but very little at a time, as well as the various effervescent drinks, are likewise useful. A cool acid drink, like lemonade or orangeade, is especially grateful to many patients. Besides this anti-emetic treatment, it is well to bring opium into use quite early; best by injections, at first, where possible, of twelve to twenty drops of laudanum in three or four ounces of water, with starch, or in urgent cases in a solution of about three grains of nitrate of silver. Internally, the extract of opium may be given, by prescribing a tablespoonful every half hour of a solution of two grains of the extract in a mixture of four ounces of water and one of syrup of orange peel; or, should the vomiting still continue, twenty-five drops of laudanum may be taken in an effervescing draught. Wood recommends a dose

every half hour of a quarter of a grain of calomel with a twelfth of a grain of opium, and in bad cases from half a grain to a grain of opium, or from twelve to twenty-four drops of laudanum at once. The selection of the preparation of opium must be left to the individual judgment of the physician in attendance. Morphia always seemed to me of less value, but it may be used subcutaneously sometimes with great advantage. Nitrate of silver, also, a third of a grain every two or three hours, after arrest of the vomiting, is an excellent remedy for the profuse discharges from the bowels. Powerful counter-irritants, a mustard plaster over the stomach, friction of the extremities with flannel, and a tepid bath where there is very great excitement and pain, are all good auxiliaries. In the dangerous cases of swift course a large blister should be raised over the epigastrium by ammonia, or the hot hammer, and morphia applied endermically. In threatened collapse administer at short intervals ten to fifteen drops of a mixture of ether and laudanum, and from time to time a tablespoonful of old Bordeaux or Madeira, to which thirty drops of our ammoniated tincture of musk[1] may be added. So soon as improvement occurs the dose of opium should be lessened, and special care in the selection of food should be taken during convalescence. For several days patients should take only spoonfuls of meat broths, soups, milk, etc., several times a day; then small quantities of well roasted meat may be taken, with seltzer-water and wine for drink, and thus there may be a gradual return to the regular diet. The bitters are of good service when digestion remains impaired.

For the treatment of cholera infantum we find excellent rules in Rilliet and Barthez's[2] work on diseases of children. Patients should have but little drink, and that of mothers' milk, asses' milk, or meat broths in tablespoonful doses every two to four hours; in addition to which they should take every two hours a grain of gray powder, either alone, or with an equal quantity of Dover's powder. These authors recommend highly also the nitrate of silver, giving hourly a teaspoonful of a solution of

[1] Note by Translator.—The mode of preparation of this tincture, which is a favorite remedy with the author, is stated on page 285.

[2] Traité des Maladies des Enfants. 2 édit. Paris, 1853. T. 1, pp. 779–782.

from a third to half a grain in two ounces of fluid. Great care should be exercised in the administration of opium to small children, and yet at the same time we must not carry our caution to excess. It would be proper to give an enema containing from one to three drops of laudanum once or twice a day; or a teaspoonful hourly of a solution of from a sixth to a third of a grain of extract of opium in three ounces of fluid. The greatest caution must be observed with the decoction of poppies, on account of the marked difference in their quantity of opium. In treating collapse, administer a teaspoonful of some good old wine, as sweet Malaga, Tokay, Alicante, etc. An excellent counter-irritant for children is to envelop them with a cloth dipped in mustard, and surrounded with a woollen cover. It may be left on from half an hour to an hour, and repeated once or twice daily if the skin be not too red. In cases of obstinate vomiting let a blister be put over the stomach.

II. CHOLERA INDICA, ASIATICA.

(Imported Cholera with its Graver Forms.)

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It would widely transcend the limits of this work if we should attempt to give anything like a critical review of the books and treatises on a disease which has a literature so rich and fertile. This subject alone would furnish a conscientious historian with material enough for a large work.

ON THE ORIGIN OF CHOLERA IN INDIA AND ITS DISSEMINATION THROUGH EUROPE IN RECENT DECADES.

There is now no difference of opinion as to the nativity of this disease, justly named the "Indian Cholera." According to the most recent investigations it is well established that cholera is as old as the human race in India, and that the mouths of the Ganges and Brahmaputra are to-day, as they have been from time immemorial, the centres of departure of the great Indian epidemics of this disease. The older documents concerning it are mostly of but little value for accurate investigation, and Hirsch very properly observes that reliable and thorough reports concerning cholera epidemics may be obtained only from the middle of the past century. As long ago as 1768–71 Sonnerat described an epidemic in the neighborhood of Pondicherry which destroyed 60,000 lives. It prevailed also in what was then French India in 1780–81, and we have reports of the cholera in Madras from the years 1774, '81, and '82, as well as earlier and later accounts from other parts of the East Indies, all of which describe its exceeding fatality. The first real, world-famous pestilence dates from Jessora in 1817, though Hirsch has proven the existence of other cholera epidemics in India as early as 1816, and in the first months of 1817, so that it is probable that it found its way from the north-western provinces to Jessora, where it first began to excite the attention of the authorities on account of its wide and general extent. I give now the history of the dissemination of cholera in its most essential features from 1817 up to the middle of our sixth decade, as I have already done on a previous occasion (Erlangen, 1854) in my lectures in Zurich on the cholera of 1854.

On August 19, 1817, Dr. Robert Tytler, of Jessora, a city

some forty hours north-east of Calcutta, was called by an Indian physician to a patient who had been seized in the night with violent vomiting and diarrhœa. The patient was moribund, and the English physician was about to make up the case in his report as one of poisoning, when he learned that some seventeen other cases had been attacked at the same time and had quickly died. So rapidly now did this epidemic spread that more than 10,000 inhabitants of Jessora and vicinity fell victims in the next two months. This was the first commencement of that fearful epidemic which has now for years spread sorrow and desolation over almost all the lands of earth.

During the year 1817 the disease prevailed throughout the whole of English India, and as early as the last part of September it reached Calcutta, where it caused a heavy mortality. Even at that time it was stated, strange to say, that the prodromic diarrhœa was very frequent. An army encamped on the banks of the Sind lost within a short time 764 officers and European soldiers, and about 8,000 Sepoys. In this first year the number of cholera victims is given at 600,000. I should remark here, however, that all statements regarding numbers are to be taken with a certain degree of allowance, as popular fear often exaggerated the number, while the caution of the authorities, on the other hand, led them not unfrequently to greatly underestimate the real loss.

In 1818 cholera spread over all Bengal, following especially the territories drained by the rivers Jumna and the Ganges; Patna, Agra, Benares, and Delhi were localities affected. In Benares alone 15,000 persons are said to have died in two months. From Bengal the epidemic spread northwardly towards Nepaul, which is to the east of Birman, then westwardly towards the coast of Malabar, and southwardly along the whole coast of Coromandel. Out of 18,000 men composing General Hastings's army, stationed between Bombay and Calcutta, 9,000 died in a short time. Already during the same year it passed over the high mountain ranges of Hindostan and Nepaul, and raged in the mountain valleys, 4,000 feet above the level of the sea, with the same virulence as upon the plains. In this year, too, it penetrated to Malacca, so that a range of territory was

affected covering thirty degrees of longitude, extending from the equator to the twenty-eighth degree of latitude.

In 1819 the intensity of the epidemic diminished in marked degree. It is an interesting fact that the citadel of Jaragurth, situated 1,000 feet above the level of the plain, lost many of its inhabitants, while a city situated at the foot of the mountain entirely escaped attack. Many cities hitherto unaffected were reached during this year; the kingdom of Aracan also was severely attacked. For the first time in the history of this epidemic it traversed the sea and broke out in the city of Trincomalee, in Ceylon. The island of Penang was attacked, and Sumatra was a special sufferer. A most remarkable fact, however, was its sudden appearance in Port-Louis, in the Isle of France, and soon afterwards in the Isle of Bourbon, whither it had been transported by ships. Although on the average the epidemic was less murderous in this year, yet its extent was greater than in the previous year, as it covered a space of forty degrees in latitude by fifty in longitude.

In 1820 Bengal was again severely attacked. It appeared again on the same islands it had reached in the previous year, and extended even to the Philippines, where its occurrence in Manilla excited a popular revolt. The epidemic now penetrated to Cochin China; several cities of China were visited, among others Canton.

The year 1821 witnessed the beginning of a new departure. After many Indian countries and especially the coast of Coromandel had been attacked, the disease passed across the mouth of the Indus and spread itself along the coast of the Persian Gulf, whence it soon extended to the interior of the land. It raged with especial virulence in Bassora, where nearly a fourth of the population fell. It soon appeared then in Bagdad, Ispahan, Shiraz. It spread also towards the east, sowing everywhere the greatest destruction, especially in Borneo and Java. Java is said to have lost 100,000 inhabitants, and Batavia alone over 17,000. The disease now covered a space of forty-three degrees in latitude by seventy in longitude.

In 1822 India was again attacked. The disease was less severe in the Indian islands, but it was gradually creeping on

towards Europe. In Mesopotamia it appeared with renewed intensity, and Syria was soon seized upon; Aleppo suffered especially. It spread out now also in Persia. From Ispahan it reached Kasan in July, 1822, Tauris in September, and soon thereafter Erzerum.

In 1823, Burmah and the empire of China, the latter especially, were severely attacked with cholera. The terror-stricken Russian authorities demanded of the mandarins to do everything possible to stay the disease, whereupon they replied that the more individuals who died, the more room would be left for the living. Cholera now showed itself for the first time on Russian soil, in the 42d degree of north latitude, northwardly from Pekin. It spread also in a westerly direction. From North Persia it invaded the empire of Russia, particularly Astrakhan, and while it raged along the Caspian Sea it did not at all spare the coasts of the Mediterranean. Among other cities here attacked, Antioch and Tripoli were especially visited. On the borders of Palestine it penetrated to the foot of Lebanon. In this year, also, Orenburg, on the extreme boundary of Europe, was attacked. The year 1823 is characterized thus by the penetration of the disease to the very borders of Europe. We find it now 1,500 leagues to the north-west of Jessora. With all its multiform variations, its spread in a north-westerly direction was at that time a marked characteristic.

In the three following years cholera made but little progress. The two threatened divisions of the earth, Europe and Africa, had yet been spared, and towards the close of the year 1826 the hope was cherished that the epidemic was near its end; but as early as the beginning of 1827 it appeared with renewed intensity in Calcutta, and here it is mentioned for the first time that many animals also showed the influence of the disease. In India it was a popular belief that the prevention of human sacrifices had excited the anger of the gods, and it is a fact worthy of record that the wife of a Hindoo in Palcala resorted to every device to obtain permission to violate the law by being burned upon the grave of her husband, who had died of cholera. She maintained that she had done the same thing four times already in previous states of existence, and that, if she might

repeat it now for the fifth time, the cholera would cease in fourteen days. The rajah at last gave his consent; but the ashes of the poor fanatic did not assuage the disease, which continued just the same in its work of desolation. The coast of Coromandel had again to suffer severely. Northwardly the cholera now reached the high mountains in the neighborhood of the Himalayas. Lahore, Kashgar, Kabul were seized upon, and from here the disease spread up to the Aral Sea.

The two following years showed no marked extension of the disease. In the autumn of 1828 it again manifested itself in Orenburg, but soon yielded when cold weather set in.

The year 1830 witnessed a new phase in the dissemination of the epidemic, which, from this time on, possessed the greatest interest for all Europe. It was now, relatively, not very severe in the English Indies and Eastern Asia, but its advance towards the north-east was more positive than ever before. It soon again extended to the coast of the Caspian Sea, and Orenburg, which had been already reached in the last months of 1829, was again attacked. Almost a tenth of the whole population was now seized with cholera, though the number of fatal cases—scarcely a fifth of those attacked—was unusually small. From this place it spread over all the neighborhood, and now the high places and mountain regions were very severely visited. In spite of isolation and quarantine the epidemic appeared in Nijni-Novgorod in the month of August. It had already been creating havoc in Persia since May, and now Teheran was seized upon, then Tauris again, where it was exceedingly severe. From Tauris it soon reached Tiflis, where, although the majority of the population had fled, the fourth part of those that remained fell victims; we repeat here, however, that we do not attach much importance to any of the numbers given.

The Caucasian mountains formed now no longer a wall against the progress of the disease, as it attacked the higher regions, overleaping the mountain chains in several places, and as a general thing following the course of streams. Towards the middle of July it again travelled from the Caspian Sea to Astrakhan, where it was not only much more destructive than before, but showed again a definite tendency to spread in the direction

of Europe. It now followed the regions along the Volga, over a wide extent of territory, and in a few months reached Saratow, 130 leagues north-west from Astrakhan. Kasan was now soon, but lightly, attacked. The epidemic spread also along the tributaries of the Volga. Besides this northern excursion, a western one soon showed itself. The territory of the Don was seized upon. The pest reached Azof and Saratow, where many chickens perished also, in their yards. Somewhat later the disease visited the coasts of the Azof and Black Seas; among other cities here, Sebastopol and Odessa were attacked. The cholera now followed up the Dnieper, reaching Novgorod and Kief in October, and extending in November to Podolia and Volhynia. From still another side it penetrated into the heart of Russia. From Saratow it advanced, after again overleaping the sanitary regulation lines, to Moscow, where it raged with great intensity from October to April of the next year. The destruction was exceedingly great in this city, but it was considerably lessened by the presence of the Czar, who came over from St. Petersburg and visited the patients in person, providing proper arrangements for their care and comfort.

In 1831 this fearful pestilence excited still further the apprehensions of Europe. It first appeared again, however, in spring, in the orient, especially in Mecca and Medina, and raged with great violence. Over 100,000 pilgrims were assembled in the two cities when the disease broke out, and here again we observe that all crowds, under these circumstances, are particularly dangerous. Soon afterwards the cholera showed itself in Syria and Egypt; it appeared in Alexandria, but it was especially in Cairo that it created unheard-of destruction; 30,000 people are said to have perished here in the first months. Though Ibrahim Pacha believed himself safe by having surrounded his court and harem with a triple *cordon*, many of the inmates were attacked. In Egypt the disease penetrated up the Nile to the higher regions of this country. Constantinople was also attacked in this year, though but lightly, while Smyrna was seized most savagely.

If we return now to Russia, we find the pestilence still raging, not only in the south, but also in the north, as far as Archangel.

Finland, Esthonia, and Livonia are visited, and St. Petersburg is attacked with especial severity. Notwithstanding the presence of the Czar in the capital, a popular revolt was excited, caused really by senseless restrictive regulations, but it was soon quieted. The central region of the Russian empire was also sharply seized upon, and from the south the pestilence spread out westwardly in two lines, south-westwardly towards Moldavia and north-westwardly towards Poland. In the first-mentioned land Jassy in particular was severely attacked during summer. But the north-western extension of the disease was far more dangerous. It stretched out southwardly from the borders of Poland towards Galicia, where Brody and Lemberg suffered severely. To the north it reached Brzesc and Grodno. Warsaw was now soon visited, and the Prussian border was overstepped for the first time at Kalisch. At Cracow there were many victims. Prussia was now attacked from another side. From Riga, where no less than one-twenty-sixth of the population perished, it passed on to Mitau ; soon it showed itself in Dantzig. From this place it entered Elbing, Marienburg, Tilsit, and Königsberg. From Poland it passed to Silesia and to the neighboring countries, Bohemia and Moravia. Following the course of the Oder it reached Küstrin and Frankfort, and now spreading itself out over the regions of the Havel and Spree, on August 30th it entered Berlin. I was myself present during the entire four months of its stay in this city. The mortality was not very severe, in all some 2,500 among 200,000 inhabitants. Fear of the disease was not great in Berlin, on account of the cheerful disposition of the people. Caricatures were even published with incredible frivolity in ridicule of the hypochondriacs who could not collect together sufficient protectives against the disease. It was at that time that there appeared the well-known cartoon upon Rust, the contagionist, who had attempted to secure isolation of the sick by a great sanitary *cordon*. The picture represented a common sparrow with the inscription, "Passer rusticus, the common land sparrow."

The cholera disappeared from Berlin at the end of the year 1831. It was observed in North Germany, at that time, that chickens and pigeons, and in many rivers fishes, perished in great

numbers. It was an interesting fact that the greatest number of persons were attacked on Tuesday, the least on Saturday, which is clearly to be attributed to the Monday excesses of the laboring classes. In October of the same year the disease appeared in Breslau, and soon spread over all Silesia. It raged exceedingly severely in Hungary, and Vienna suffered also in this year from a widespread, though not very fatal epidemic. The course of the disease along the territory of the Elbe attracted attention. Among the cities here attacked were, successively, Magdeburg and Hamburg. The more western excursion took its departure chiefly from Vienna. In North Germany, although the disease was very widespread, it spared the territory along the course of the Rhine. The Scandinavian countries were perfectly exempt from attack, excepting a light epidemic in Stockholm, which reached this city through Finland in the westward march of the disease from St. Petersburg. From Hamburg it overleaped the sea, and on October 26th, 1831, reached Sunderland, on the east coast of England. Soon now it spread itself over the islands of Great Britain. London was attacked in January, Edinburgh in February, and Dublin in March, 1832. From England it was carried over to France, just as later in 1849 and 1853. In March, 1832, it showed itself in Calais and Paris. It excited the greatest terror in Paris, where it raged with extraordinary intensity, destroying about one forty-third of the whole population. Here, too, it excited a dangerous popular revolt. The people complained here, as in many other places, that the wells had been poisoned, and this caused the great mortality. From Paris the disease spread out northwardly. On the north-west it passed into Brittany, some 120 hours' journey distant from Paris, while its southern radiation scarcely exceeded 30. A new phase in the epidemic presented itself towards the middle of the year 1832, when the cholera crossed the Atlantic Ocean and appeared in North America, with especial violence in Canada. It was very severe in Quebec and Montreal. New York was attacked as early as July, and shortly thereafter Philadelphia and Baltimore, in succession. The epidemic ran through the country as far as New Orleans, which was reached in November, 1832, and in the summer of 1833 it invaded the Mexican states.

Here it was most severe in the cities Vera Cruz and Mexico. This epidemic, many particulars of which I have received from several practitioners, was not only very destructive, but was most remarkable from the fact that it reached a city higher above the level of the sea than the highest Alpine pass in Europe. The epidemic had almost ceased in Europe at this time, when it again broke out in June, 1833, on the coast of Portugal, where Lisbon was visited with especial severity. In North America, the north-western march of the disease passed over 3,000 or 4,000 miles. The leap from Mexico to Portugal was somewhat after the manner, as if it were about to return to its first point of departure, in an opposite direction to the first ellipse about the equator. In the winter of 1833, and in the year 1834, cholera prevailed in Portugal and Spain, in which countries the interior was first attacked and afterwards the coasts. In Madrid, Seville, and Barcelona it was especially severe. Spreading now eastwardly from the coasts of Spain, it attacked Cette, Marseilles, Toulon, Nice, and Genoa. From this place it entered Lombardy, and Piedmont, attacking such places as Coni and Turin, and finally reaching Leghorn, Florence, Triest, etc. In 1835 it passed over from Spain into North Africa. A large part of the Mediterranean coast was attacked. None of the islands suffered but Malta, where one-fortieth of the population perished.

In the years 1836 and 1837 the disease prevailed again in Italy, especially in Naples and Rome. In 1836 Munich was also attacked, and South Bavaria and Tyrol severely. In the summer of 1837 it again entered Berlin, Breslau, and many places in East Germany. In October, 1837, it prevailed in Algiers, over a pretty wide extent. With this year ended this great, almost world-wide, epidemic, which in 1830 had manifested a renewed intensity. But in all these twenty years we observe, on the one hand, that it mostly extended in a north-westerly direction, and, on the other, that it was continually breaking out with renewed intensity at its centre and point of departure in the East Indies, when its extension would become still greater.

But this interruption in the prevalence of the disease did not last long, and perhaps even there was in reality no interruption. As early as the beginning of the fourth decade, we see the cholera

again severe in India, especially along the courses of the Ganges and Sind. From here it again reached Cabul and Bokhara, and appeared as early as September, 1845, in Samarcand. In 1845 it prevailed severely in all Persia, spreading especially from the east to the west. Thus it travelled from Meschid to Teheran and Bagdad. In Teheran, a city of 130,000 inhabitants, 7,000 are said to have perished. From Bagdad it travelled northwardly along the courses of the Tigris and Euphrates; we see it again passing southward to reach Bassorah. A great part of Arabia was next attacked. In Mecca and Medina it appeared again in November, 1846, and again caused extraordinary destruction among the assembled pilgrims. Up to this time the cholera had travelled from Meschid to Mecca, about 625 leagues, in ten months, or something like 55 leagues in a month. In the two last months of 1846 it travelled over a distance of 120 leagues, again overleaping the Caucasus to appear in Astrakhan. From this time on, it followed the course of the Volga, until it reached the north of Russia. In another line of extension it went out from the east towards the west, particularly along the Kour, penetrated Georgia, reached Trebizond, and on October 24th, 1847, it broke out in Constantinople, which now became a chief centre of radiation. From Constantinople all Syria and a large part of the countries about the Mediterranean Sea were attacked. Roumania, also Wallachia and Bulgaria were severely visited. To the north it again entered Russia, raging as a most violent epidemic, most especially in Moscow. Poland was now seized again, and the bordering provinces of Prussia, as well as Galicia, Bohemia, and Hungary, from another direction; then a large part of North Germany, especially Berlin, where it prevailed in 1848 with extraordinary intensity. Following the course of the Elbe, it again passed to Hamburg, and from there over the sea to England, particularly to London, and thence to France. It broke out in Paris on March 11th, 1849, after it had previously appeared in a poor-house in St. Denis. I happened to be at the Hôtel-Dieu when the first patient was brought in, presenting already a perfect picture of cholera asphyxia. The disease lasted here up to the end of the year, a period of about nine months. At first it spread slowly, attack-

ing rather the poorer classes and debilitated persons; then it gradually seized upon all classes of people until it reached a hitherto unheard-of intensity, particularly during the first eight days of June. The number of dead daily varied between 700 and 900. General terror was excited over the whole city. Hearses no longer sufficed to carry corpses to the cemeteries, and transport vehicles of all kinds, even artillery munition wagons, had to be impressed for service. At the same time the heat was oppressive, while the weather was clear and beautiful. The greatest contrast was exhibited between the profound desolation on the one hand, and the extreme frivolity on the other; often while I was returning home at night or early morning, deeply depressed by scenes among the sick and dying, I would meet parties on the way pale and reeling from the excess of their nightly orgies. On June 9th, a severe storm occurred, and from this day on the number of sick and dead markedly diminished, so that the fearful epidemic was almost forgotten during the political excitement which prevailed in the riot of June 13. Still, lighter forms of the epidemic continued to recur quite frequently. Some 10,000 inhabitants in all fell victims to the disease. Many of the patients operated on in the hospitals died of cholera. In several localities the intensity of the disease was most strongly marked; that experienced in the Salpetrière, the hospital for aged females, was almost unknown in the past history of the epidemic. Of the 5,000 inhabitants of this great institution, about 1,200 perished with cholera, and during the first three months this locality furnished almost one-fourth of the cases attacked, and one-third of the whole mortality. This local epidemic left far behind it that of Wall street, in Berlin, in 1848, which furnished only one-twentieth of all the fatal cases.

A large part of France was now attacked, and the disease prevailed in almost all Middle Europe in this year, during which it again reached America, towards the close of the year 1848, entering, not at the north as before, but at New Orleans, whence it spread in various directions.

This second great epidemic presented a somewhat similar course to the first, but with manifold differences in the details and modes of its dissemination. The ellipse of its whole course

covered, in the same direction, a wider space. Yet there escaped, in their central parts, Switzerland, Savoy, a part of the mountains of Tyrol, and, to a tolerable extent, the course of the Rhine, the Rhone, and the Isère, especially in their upper regions. Immunity from the disease was limited, however, to a much smaller number of places, as compared with previous epidemics; this was particularly the case with that of 1854.

This second epidemic passed almost without interruption into the next. Before the end of the year 1850 it showed itself again in Persia, but we do not know whether or not it reached this country again from India. In 1851 and 1852 it produced the greatest destruction in this part of Asia, extending, as had both preceding epidemics, to the southern range of the Caucasus. The Black and Caspian Seas, Moscow and St. Petersburg were now again attacked in succession. The territories of the Volga and Dnieper suffered severely. Towards the end of the year 1852, and the beginning of 1853, Poland, the neighboring Prussian provinces, and later Berlin and Hamburg were again attacked. To the north the disease spread as far as Archangel. The Scandinavian countries were seized with great intensity. England and, later, France were attacked in 1853, the latter, especially in 1854 and 1855, over a wide extent. The coasts of the Mediterranean Sea, Marseilles, Genoa, and many other points, the Greek coast especially, were all seats of the disease. In South Germany it prevailed in those countries in which it had manifested itself in 1836. In Munich and Augsburg it was especially severe.

The cholera now entered England again in 1853; but it was not until 1854 that it prevailed to a wide extent in England, Scotland, and Ireland. In 1853 and 1854 it extended over a considerable portion of the United States of America and the Antilles. In 1854 and 1855 it showed itself in Switzerland. Its spread and desolation during the Crimean war are well remembered. South America also, spared up to this time, was now severely visited in 1855, in Brazil.

As to the dissemination of cholera in Switzerland, I may refer to my work, already cited, On Cholera in Switzerland (Frankfort, 1856), from which I give here only a very short

extract. It is most astonishing that the opinion should be generally accepted that Switzerland had escaped an attack up to the year 1854; the fact is, the canton of Tessin was long ago the seat of the disease. Cholera first appeared in Lugano and Mendrisio and their vicinities in July, 1836, having crept in from the province of Como; but it did not pass over Monte Cenere. Quite the same conditions prevailed in 1849, while in 1854 and 1855 Magadino, on Lake Maggiore, and Cadenazzo, places on the other side of the mountain, were attacked. It is remarkable that while the disease was transported from Genoa to Tessin in 1854, nothing similar happened to the cholera fugitives who came into the valley of the Rhone over the Simplon pass, and the light Geneva epidemic, mentioned later, was not carried over Mont Cenis. The Tessin epidemics lasted, on the average, about three months, but were never very marked. The first really great epidemic in Switzerland was that of 1854, in Aarau, where it first broke out in the poor-house and then rapidly spread over the city. It is probable that it was imported from Munich, where it was raging, as well as in Augsburg, in 1854, with great intensity. I observed a light local epidemic in Zurich in 1854; but the greater epidemic did not occur until the following year, when the disease, having been imported probably from Alsace, appeared in epidemic form during the spring in Basle, and also in the canton of Baselland. That portion of the city of Basle situated below the general level was especially attacked, while in Zurich, later, it was the higher regions of the city which were the chief seats of the disease. In both cities the epidemic lasted about ten weeks, and in the country regions six weeks. A light local epidemic showed itself also in Geneva in August and September, 1855; it was probably imported from France and attacked in all but ninety-two persons. Among the greatest of the Swiss epidemics is that of 1867, which has been excellently described by Zehnder, and concerning which we are indebted to Biermer for some very valuable communications. Strange to say, a light, inconsequential epidemic appeared also in the village of Branson, opposite Martigny, in the canton of Valais.

In later years cholera has broken out in many places in middle and northern Europe, and has become even epidemic in some

cities, as Warsaw and Königsberg, but it never assumed the pandemic character which we have observed in the first twenty-five years of the disease in Europe, and which we notice for the last time in 1866, during the German-Austrian war, when almost more Prussian soldiers were killed by cholera than by battles. Breslau, a city so often visited by cholera, never had so murderous an epidemic as that of 1866, in which—aside from all the lighter cases and those of cholerine—something like the twenty-fifth part of the whole population was attacked, and that with a mortality of over 50 per cent. I shall return later to some geographical considerations concerning the influence of altitude, but I am constrained here to communicate one result of my investigations into the epidemics of Switzerland—a result to which I have hitherto found no exceptions in middle Europe—viz., that the cholera in Switzerland in no case ascended higher than 6–700 mètres above the level of the sea.

A retrospective view of the course of the disease up to the present time teaches us that the most different parts of the earth's surface have been reached by the disease, in its pandemic form, and that the islands, lands, and countries hitherto exempt, such as for instance a part of the coast of West Africa, the Polynesian Archipelago, a part of North America, some of the northern countries of Europe — Lapland, Iceland, etc. — owe their immunity partly to their comparative isolation and partly to accident. On the other hand, it is quite possible that favorable conditions of soil and drinking-water may oppose great obstacles to the development of cholera germs in different places. The constant escape of certain cities and regions during the last four decades, even in the midst of great and destructive epidemics, is a strong argument in favor of this view.

ETIOLOGY.

Although the fundamental cause, the specific entity of cholera, is not yet positively known, the very great variation of influence of all other etiological circumstances leaves for our acceptance but a single ultimate cause, a cholera germ. This germ must be accepted—in fact, it is now almost universally

accepted—as the very probable cause of the disease, the *semi-nium morbi*. This statement I may make now, at the start, as corollary to what has already been said of the history of cholera. The mycetic theory, which ascribes the origin and development of cholera to parasites of the lowest form and smallest size, corresponds more fully than any other hypothesis, and is in more perfect harmony with all observations hitherto made concerning the etiology of the disease. It is easy to understand that a minute, specific, and peculiar Indian parasite might develop its action, wherever it is carried, when it finds favorable conditions for prolific reproduction. As the plague was cosmopolitan in the middle ages, and as that most widely disseminated of all parasitic diseases, small-pox, has found opportunity for development under the most diverse external circumstances, so it is likely that cholera owes its pandemic character to the same conditions.

I have already repeatedly expressed the opinion that the universally accepted specific cholera germ must be either an organic poison or a living organism. But in the whole range of toxicology, a subject now so accurately understood, there is not a single observation that speaks even approximately in favor of the purely toxic nature of the cholera germ. Moreover, no one has hitherto ever been able to demonstrate, empirically, an organic poison as the cause of any infectious disease, though a great number of incontestable facts have already accumulated, and are rapidly increasing, which bring infection directly in connection with the development of the lower vegetable parasites. The discredit cast upon the parasitic theory of infection by improperly supervised breeding experiments, which claimed to prove a transformation of the smallest unicellular plants into the larger and more complicated forms, has long ago been perfectly removed by a series of thorough and unassailable observations. The difficulty of directly demonstrating a cholera parasite is certainly a great one. It is almost certain that it belongs to the protomycetes; probably to those of more rounded forms; but unfortunately so many other similar formations, normal and innocent in nature, are present in those parts in which cholera exercises its chief effects—for instance, in the gastro-intestinal

tract—as to render the solution of the question extremely difficult. It is to be hoped, however, that a very accurate study of the mycetes of the normal intestine will lead to a recognition of the peculiarities of those in cholera; and I would say here that it is of especial importance to closely search for these parasites in the interior of the follicles of the small lymph and blood-vessels and of the submucous connective tissue. They may be found also later in the distant internal organs. It will be remembered that we have quite recently discovered that the mycosis intestinalis is a special disease of the intestine, connected with anthrax.

The mycetic theory explains, without strained effort, why it is that fluids, and especially stagnant fluids, containing more or less organic nutritious matter, are chief vehicles for the cholera germ, as they are for all the protomycetic forms. It is on this account that the water of the soil, drinking-water, and every other fluid play so highly important a rôle in the diffusion of the disease, and yet neither the ground-water nor drinking-water theories can ever prevail in sole sovereignty as causes of the disease, because they alone, as such, are not necessary for the development of the cholera germs, but only become so when they can furnish these germs with proper nutritious matter, when other favorable conditions of growth are presented, and when, more especially, the way of communication with the human organism is open. The germs of cholera may be spread without ground- and drinking-water just as easily as with them, through the air, by becoming attached to solid bodies, etc.

The contagion of cholera stools has been especially brought out as an argument in favor of a cholera poison, and the important fact has been put forward with particular emphasis, that it is not the fresh cholera excretions which are contagious, but those which have undergone alteration after a few days. Now I should hesitate to subscribe to this statement without reservation, for there are certainly examples enough of very rapid contagion by means of fresh excretions. No one of the many chemists who have closely examined cholera stools has ever demonstrated a cholera poison, while bacteria and other mycetes are of constant occurrence in the dejections. Here, too, means should

be discovered to solve the question of specific mycetes. The perfectly fresh discharge should be immediately put into glass cylinders, which should be stopped above with cotton, and then brought into the breeding chambers to observe whether and in what manner mycetes are here developed, what kind they are, and what action they may perchance manifest during the experiment. As now the sources of error under such circumstances are not few, these investigations would only be of value after a series of parallel experiments had been made which should compare, first, the development of bacteria in the stools of common diarrhœa; secondly, those in the typhoid fever stools; thirdly, those in the stools of dysentery; and fourthly, those in cholera. Should constant differences be present in the excretions of the different diseases, we should possess points, the value of which could scarcely be overestimated for further etiological mycetic investigations. I have already commenced the attempt to solve these questions experimentally in my laboratory. The opponents of contagion by the excretions of cholera have hitherto always had in their favor the fact that the contagion has never been demonstrated either experimentally or by the discovery of specific cholera germs. It will be understood, of course, that mycetes could only be present in the profuse stools of cholera in scattered numbers; they would be less destructive, therefore, than where the stools are more concentrated; but their action would be increased from day to day in a twofold manner, by increase in concentration of the stools, and also by swiftly augmenting multiplication.

These lowest organisms, as is well known, live in the air as well as when attached to different solid substances. But they lead a much less active life, and their capacity for increase is much diminished outside of fluids, and thus while the air and other substances may certainly transport cholera, they are less active agents of dissemination than the fluids in which the parasites have already undergone considerable multiplication. When cholera prevails in a large city with great severity, the number of persons attacked with real cholera is always relatively smaller than those attacked with choleraic diarrhœa and cholerine. Moreover, choleraic diarrhœa occurs much more fre-

quently in places somewhat distant from the centres of the disease, while true cholera prevails in these centres especially. In all these cases it is probably the diminished capacity of the air for infection which accounts for the relatively greater dissemination of the lighter forms of the disease. But these lighter forms may lead, by rapid multiplication of the germs of the disease, under favorable conditions of the organism, to dangerous attacks of cholera.

From what is known of the whole life of these lowest organisms it is readily understood that the air cannot be the chief agent in the dissemination of cholera, although it certainly may not be wholly excluded from this rôle, as has been occasionally maintained in quite recent times. It may be as easily comprehended also that when the germs are fixed to some lifeless substance their activity is increased according as they are subsequently brought into contact with fluids; hence the so well known, frequent infection of washerwomen through the cholera linen. The highly important rôle played by the water impregnating the soil is no doubt due to the fact that if it be rich in nutritious matter for bacteria, it acts as a breeding-place for the minute infectious parasites; and yet the agency of ground-water alone cannot be absolutely necessary for the dissemination of the disease. Cholera finds in drinking-water also a very frequent and most potent medium of dissemination, as it may be impregnated with germs (from water of the soil or by filtration from privies and sewers), which may then flourish in further development; still, drinking-water alone cannot be considered as the exclusive or necessary means of dissemination. Overflowing or badly cemented drainage and sewer pipes, for instance, conveying infectious matter, may carry their foul contents directly into the ground or walls of cellar dwellings, and swiftly develop their destructive action among the inhabitants. So also great civil or military movements often stand in direct relation to the spread of the disease; thus the war of 1866 was a very lively reminder of the injurious influence of movements of great bodies of troops. It may be readily understood, however, that at times the most active military or civil movements may take place, and even numerous cases of the disease occur through contagion,

and yet the disease may nowhere establish itself as an epidemic, or at least in but very few places. The last three years furnish numerous examples of this fact, which may be explained by the supposition that at certain times and places the conditions for the development of cholera germs may be very different, now very favorable, again very unfavorable; a fact that is characteristic of the whole world of the fauna and flora. The cholera draws itself thus like a red line through conditions seemingly very different; it recognizes no element of dissemination, not even that most frequently injurious, as the sole sovereign and dominant factor in its etiology. Among the reasons why the disease does not fully develop under apparently favorable conditions, we may notice here again the fact that the germs may reach even an exuberant growth in the water of the soil and then be destroyed by otherwise innocent bacteria of putrefaction and fermentation before they have come into thorough contact with the human organism. A specific germ, a favorable medium of development, sufficient contact with the human organism, only slight and temporary development of the protomycetes destructive of the cholera germs, these are the fundamental conditions for the development and diffusion of cholera to any great extent, and every perturbation, every solution of continuity in the chain of these factors of development may prevent or lessen its destructive action.

The natural history of the protomycetes teaches us again that the exuberant growth of the cholera germs may be brought to an end, even when at the height of their destructive activity, by the development of other harmless parasites. Daily observation shows us similar occurrences in our bacterian cultivation chambers, and the chromogenous varieties, so valuable for our investigations, may be quickly displaced by the development of other species of bacteria. We observe here a confirmation of one of the most remarkable laws in the economy of nature, by which a certain adjustment is effected between the various destructive organisms and the general harmony of development, and the continuance of all varieties of growths is maintained intact. Thus matter which has already become lifeless yields its nutriment to living structures, while the relatively exces-

sive growth of individual groups is arrested by a sufficient check.

Experimental observations have not yet thrown much light upon the development of cholera. Much has been said already, it is true, about the cholera of animals, the death of birds in forest and field, and of the domestic house fowls, but an animal cholera has never yet been scientifically established. All the experiments by inoculations and injections of cholera stools, under the skin, into the veins, into the digestive tract, by Magendie, Lindsay, J. Meyer, and others, have yielded nothing in the way of positive results. Even the celebrated experiments of Thiersch, of feeding white mice with strips of paper saturated in a solution of dried cholera stools, have furnished no convincing results, although the statement, that all the symptoms which occurred were explicable by sepsis, is not reliable.

If we regard now the manner in which cholera usually spreads, we again notice facts more in unison with the parasitic than with any other theory. Although the first great marches of the disease were characterized by an unmistakable direction from east to west, it is now firmly established that cholera spreads by preference in no particular direction, but that it may pursue a course just as readily from west to east, from north to south, or vice versâ. Quite frequently, indeed, there is no definite course at all, and the disease irradiates from every given centre in every possible direction, as determined chiefly by lines of travel, or more especially by cases, lightly or perhaps already severely attacked, whose effects, emanations, stools—these latter by no means exclusively—spread the contagion and transport the disease, particularly when the conditions of the water of the ground, the drinking-water, and their contact with human beings encourage an abundant development and action of the cholera germs. Transportation of the disease occurs in this way most markedly and most instructively by travel in regions but sparely populated, or in places even abundantly populated, by individual cases, as is positively shown in a whole series of instances in the transport of criminals or prisoners.

As regards the rapidity of dissemination of cholera, the trouble has been taken to compute a medium rate of travel in

one day. The incorrectness, even puerility of such calculations is apparent; for if cholera be transported from place to place by the railroad, its rapidity of dissemination may reach twenty-four miles an hour, if by the march of troops, twelve to sixteen miles a day. But what numberless accidents may not intervene to interrupt it! In one epidemic the disease spreads from Warsaw to Breslau in a few weeks, in another it extends only to the immediate vicinity; while the cholera is raging in Dantzic and Königsberg, railroad trains make daily trips to Posen, Breslau, and Berlin, and yet it is only rarely that the disease is permanently transported. At other times the disease is extended by wooden rafts along the Vistula or Oder or other river, in seeming confirmation of the generally accepted opinion that it follows the course of streams. Here, too, various intervening accidents play a most important rôle. Should numerous cholera germs enter a stream, they may only spread the disease when they are transported to places and are under conditions which favor the proliferation of the germs and their contact with human beings, and thus not unfrequently it is the raftsmen and boatmen, with their families, who infect the various landing-places. Dissemination of the disease on a grander scale occurs in quite the same way by sea voyages from one part of the earth to another; and when cholera breaks out in the open sea, after the ship has been out some time on the journey, it is evidence only that the germs of the disease have been present in the ship from the start, in some of the passengers or effects, and is in no way proof of a so-called autocthonous origin.

The manner in which cholera attacks persons who come in contact with patients, their discharges, linen, or dead bodies, is perfectly in harmony again with the parasitic theory. I have noticed in all epidemics, and have seen it mentioned in the writings of many authors, that practising physicians, even hospital physicians, are seldom attacked with cholera, because, although they come in contact with many patients, their stay with each is short, and because, when themselves attacked, they immediately treat the prodromic diarrhœa. But the resident physicians, and more especially the assistants and nurses, are much more frequently attacked. Their contact with the sick is much more

protracted, and not unfrequently local epidemics are developed in hospitals, which infect transient visitors rarely or but slightly, while residents, or those whose stay is longer, are attacked much more frequently and intensely. Should the cholera germs be very numerous they may generate new attacks in the most manifold way through the air, through water, effects, etc. It must clearly be cholera germs, again, to which is due the frequency of these attacks among washerwomen. Whenever they wash linen soiled with cholera dejections, without any precaution they are attacked in all places in no small numbers. In Branson, in the canton of Valais, in 1867, one of the Sisters of Charity nursed, with the greatest self-sacrifice, all the cholera patients in very filthy chambers, and yet remained healthy. At the close of the epidemic her sympathy prompted her to assist in washing up the soiled linen, when she was attacked with the disease and died. It was from a washerwoman, who died after washing the clothes of a cholera fugitive, that the epidemic developed later in Zurich, in 1867. Of course, a rational prophylaxis, to which we shall return later, may prevent the occurrence of these unfortunate cases.

The manner in which transportation is effected is often involved in great obscurity, for the germs may be disseminated and the disease spread by subjects of choleraic diarrhœa who have subsequently recovered without further symptoms, or by the but slightly soiled linen and other effects of cholera patients. We know how invisibly and variously bacteria usually spread themselves, and we know that it is not possible for the most carefully organized sanitary police to subject every cholera germ to inspection.

As to the influence of dead bodies, I must confess that I doubt it very much. We occupied ourselves almost daily in Paris, in 1849—my friends and myself—with investigations into the pathological anatomy of cholera. In Zurich, in 1855, I made all the post-mortem examinations, with my assistant, Dr. Wegelin, and neither of us, and no one of our dead-room attendants, were attacked with the disease. I consider it, therefore, merely an accident when a body-carrier falls sick. I believe, indeed, that putrefaction rather diminishes the capacity

for infection, and that the bacteria of decomposition destroy the germs of cholera.

The fact that there are in every epidemic individual centres where the cholera prevails with intensity, while it is relatively very light in the nearest vicinity, as in the next house or across the street, is a positive proof how much local and localized influences may affect the development of the germs, and thus the disease itself. The most extensive local epidemic under my observation was at Paris, in the Salpetrière, the large institution for aged females. Of the 5,000 inhabitants of this immense range of buildings no less than 1,200 were attacked with the disease.

The much agitated question concerning the contagion of cholera, whether, if it be considered contagious, it is spread by a miasma or contagium, must be considered, under the light we now possess, as follows: that cholera can be spread only by contagion, *i.e.*, by germs which are carried from a diseased to a healthy person; but that these disease germs infect only comparatively rarely by intercourse or contact with cholera patients, since they possess relatively but little vitality in the air of the sick-room, and are present mostly in inconsiderable quantity. On the other hand, a certain number of the germs and a given vitality are necessary for the propagation of the disease, and these conditions are better met in fluids than in the air; hence contagion is more frequent when the germs are communicated through a fluid than when transmitted through the air. Should the germs of cholera excretions fall into a privy, for instance, and from here find their way by filtration into drinking-water or subterraneous habitations, the individuals who had appropriated the most germs would suffer most severely. The danger of contagion in cholera, therefore, is relatively less from direct contact with cholera patients than from frequent contact with the insidious and latent germs proliferated from these patients. As these germs are more or less confined to their localities of origin, and as they develop more especially in fluids, the water of the soil and drinking-water must play an important, although not an exclusive, rôle as vehicles; cholera excretions, too, are the frequent, though by no means the sole, carriers of the germs; indeed they may even lack every element of contagion. We are

justified at the present day in attaching but little etiological value to the idea that cholera may spread its contagion to great distances under certain conditions of the atmosphere and with certain winds.

From the fact that the diffusion of cholera occurs more frequently in the moist than in the dry state, we come naturally now to the consideration of the highly important influence of the condition of the soil, the ground-water, and the drinking-water in the spread of the disease. It is perhaps scarcely necessary to state that notwithstanding the fullest appreciation of the immortal merit of Pettenkofer in establishing the influence of the soil and of the ground-water, notwithstanding the no less important influence justly ascribed to drinking-water, I cannot in any way subscribe to either of these theories exclusively. Opposed to each of these large groups of positive facts stands a series of well-observed allied negative facts, which warn us to be cautious in our judgment.

The most comprehensive and careful investigations during the first decades of cholera in Europe established the fact that conditions of climate and weather had little or no influence. It was on this account that the uninterrupted labors and profound studies of Pettenkofer, which began in Munich with the epidemic of 1854, were greeted by all investigators in this field with an enthusiasm certainly at times excessive.

If we enter first now into the study of the conditions of the soil, we must notice above all things the influence of situation with regard to elevation. This influence is less marked in the southern mountain chains of Asia and America than in the northern. In fact the cholera shows us here, in the first decade, how it leaped over high mountains and prevailed on lofty plateaus, 6,000 to 8,000 feet above the level of the sea. In middle Europe, however, more especially in Germany and Switzerland, it may be said, empirically, at least, from observations during forty years, that the cholera did not as a rule ascend above a height of 2,000 or 2,700 feet. I know of no place in Switzerland, neither in the Italian nor in other cantons, in which cholera ever prevailed above a height of 2,300 feet, and yet there is a not inconsiderable population at this level.

In the same localities cholera often occurs earliest and most intensely in the lowest parts of cities and regions of country, although there are numerous exceptions, as I observed, for instance, in Zurich, in 1855, where the chief centre of the disease from the start was and remained in the highest part of the city. Long ago it was observed in English India that the higher forts enjoyed immunity from attack, while the disease raged in the valleys in immediate proximity. Hirsch also cites some interesting examples showing that troops, after having been decimated by cholera, escaped its ravages so soon as they reached the higher mountains. The favorable influence of height even in India is therefore to be admitted. The same author emphasizes the fact that the disease prevailed relatively but very lightly upon the south-western plateau and the mountainous regions of Austria, Styria, and Carinthia, while the lower lands were much more severely attacked. The same thing has been observed also in the Sudetic and Carpathian mountains. As long as twenty years ago Farre made the statement that the number of attacks and the mortality of cholera stood in inverse relation to the elevation of the ground.

The geological structure of the soil has of itself but little influence upon the disease, for, since Pettenkofer's reports, it is admitted that it is the physical rather than the mineralogical structure which most concerns cholera. Porous soils, which permit the penetration of moisture and fluids, especially facilitate the diffusion of cholera; while a rocky, solid subsoil, immediately beneath the surface, is much less suitable. But the porous condition alone is not effective when it reaches to a certain depth, or when the fluids traverse the soil so quickly that they cannot form localized accumulations. Nothing is more permeable to atmospheric water, for instance, than alluvium and diluvium, which reach a depth in North Germany of from 150 to 250 feet, or of 130 feet even at Breslau; and since the noxiousness of ground-water stands in inverse relation to the depth at which it lies, we cannot consider the otherwise porous alluvial and diluvial soils to be unfavorable conditions, unless assisted by other geological relations, such, for instance, as great inequality in the thickness of the diluvial layer in the same region. For

instance, there are many places in Breslau where the oligocenic brown-coal formation exists at a depth of from twenty-eight to thirty-two feet. Here, then, we find, at a very slight depth, layers of solid stone beneath the diluvial rubble. Far more important, however, is the closely packed alluvial clay, which often lies at little depth, and prevents the escape of the ground-water downwards, thus favoring its accumulation and the development of parasitic organisms.

I have shown in my work on the typhus fevers of Breslau that this superficial layer of clay, the most impenetrable kind of soil, is encountered in places at the slight depth of from sixteen to thirty-two feet. The presence of this clay over so wide an extent is one of the chief reasons why Breslau is so predisposed to frequent and dangerous epidemics. But if this layer were penetrated for the purpose of obtaining water at a lower depth — an experiment easily made by boring — this water, if found, would be far less unclean, because less exposed to sources of impurity. It is to be hoped that the new water-works which supply us with water from the Oder, above the city, will be found to have worked favorably in this regard; still, there are other sources in the vicinity suitable for water supply. Pettenkofer is perfectly right, therefore, when he emphasizes the danger of porous soils with water at the slight depth of from five to fifty feet. But he certainly goes too far when he maintains that this condition of the soil is indispensably necessary for the development of cholera. I shall not now notice the objections raised by others, but I may say here that the influence of ground-water was not proven in Zurich in the epidemics of either 1855 or 1867. In 1855 the centres of the cholera epidemic were markedly separated, and no connection was observed between houses and cloacæ, nor was there any similarity in the nature of the soil of these different centres. In this epidemic the disease broke out in the higher regions, where the subsoil was relatively solid, while it spread only slightly in the lower part of the city which rests upon gravel, old glacier, and moraine soil. That portion of the city which lies along the lake and on the banks of the Limmat, where the soil is thoroughly permeated with moisture, was relatively but little affected, while the higher

and rockier regions, poor in ground-water, became the centres of the disease. Zehnder, in his excellent work on the cholera epidemic of 1867, gives a most thorough description, based upon the latest and best geological and hydrological researches concerning Zurich, of the local conditions, surface conformation, geological structure, soil moisture, level of the ground-water, temporary variations in moisture, etc., and arrives at the conclusion (at the close, p. 73), that no connection could be established between soil moisture and the occurrence of cholera; and these conclusions are based upon the thorough geological investigations of Escher von der Linth, and the hydrological studies, during the epidemic too, of the highly competent Bürkli. Now I shall, nevertheless, not dispute Pettenkofer's statement as to the important influence of ground-water upon the diffusion of cholera, but I must certainly doubt the truth of the claim that cholera may never become epidemic without these conditions of the soil.

Marshy and malarial regions form favorable soils for cholera, because they are so well adapted for the development of parasitic germs; and it is because of the ease with which sewer fluids filter through the soil, that cellar habitations are especially frequently visited in cholera epidemics. Hirsch has collected a great number of examples showing the influence of low places, the lowest and most moist parts of cities and dwelling-houses, and cholera germs are no exceptions here, as a high degree of dampness very much favors the development of protomycetes.

There can be no doubt, therefore, that great humidity of the soil, and especially accumulations of ground-water in the superficial layers, may be regarded as among the chief breeding factors of cholera germs. Another statement of Pettenkofer's has also met with confirmation more frequently than contradiction, namely, that it is not the high stand of the accumulated ground-water, but much rather its fall, which is most liable to diffuse the germs of infectious diseases, and thus favor epidemic outbreaks of cholera.

We arrive now at the so important question of drinking-water, regarded by some as the sovereign agent of dissemination of the disease, and by others again as of but little significance.

Pettenkofer seems to belong to the latter, and he lays especial stress upon the fact that the Indian physicians, particularly Bryden, notwithstanding their extensive investigations, are not willing to grant to drinking-water the least influence. It is certainly not at all impossible that the very different conditions of drinking-water may alter its influence at different times and in different countries, *i.e.*, that infection of the water in cholera epidemics may not occur at all at times, and again at other times be very marked. There can surely be no doubt that infected drinking-water may act just as injuriously in spreading cholera as that pure drinking-water, which is free from all infection, may exert a favorable influence in staying the disease. It is interesting to note the different interpretations put upon the celebrated observation of Snow, who established the connection of the fearful local epidemic in Broad street, London, in 1854, with an infected well; the epidemic ceasing on the day when the well was closed. Bryden denied here, too, any influence to the drinking-water, and stated that he had seen exactly the same thing in Indian regiments on the march, after they had remained over night in an infected place. But if we look at the reduction in the number of the sick, even before the closure of the well, a fact upon which Bryden lays great stress, it does not seem at all improbable that the people in the vicinity, frightened at the great mortality, took less and less water from the well every day. Griesinger justly cites as of especial importance the fact communicated by John Simon, that in the houses in London supplied with river water, drawn from the stream after it had received the contents of a large number of sewers, so that it had forty-six grains of solid constituents to the gallon, the number of inhabitants who died of cholera was 13 to the 1,000, while in the other houses, in exactly the same circumstances, save that they were supplied with water containing only thirteen grains of solids, the proportion was 3.7 per 1,000.

I select now, from a great number of examples, only a few from a recent work of Frankland on the Water-Supply of London and the Cholera.[1] On the 18th of August, 1866, a family

[1] The Water-Supply of London and the Cholera. Quarterly Journal of Science, 1867.

removed from London to Margate; on the 26th there was a storm, with a heavy fall of rain, and the water had an unusual odor and taste. On the 27th four persons were attacked with cholera, and on the following day still more, the most of whom died. The water in the well at the end of the garden furnished, in 100,000 parts, 93.4 of solid matters, of which 7.36 parts were of organic or volatile nature. The cesspool adjoining the garden had clearly poured its contents into the well after the overflow caused by the rain, and this had caused the fatal contamination; for an analysis made September 18th, showed 82.75 solids, of which but 1.13 parts were of organic or volatile nature. It was proven that all who were attacked had drunk from the well. A similar occurrence was established by Dr. Lancaster, of Epping Forest. The Broad-street pump, as already mentioned, caused the fearful outbreak of cholera in the parish of St. James.

The inhabitants of London who used Thames water from Kew, above London, showed a mortality from cholera of 8 to 10,000; those who used Thames water from Hammersmith, 17 to 10,000; those from Chelsea (both places are further up the Thames), 17 to 10,000; those from Battersea to Waterloo Bridge —this is water that is contaminated in the city—163 to 10,000. In 1854 only the half of a district was supplied with water from Teddington lock (a lake), and the mortality was 87 to 10,000; in 1866 all the water was drawn from Teddington lock, and the mortality was 8 to 10,000.

Manchester suffered terribly from cholera in 1832 and 1849, when the water was impure; now the water is derived by aqueduct from the interior of Derbyshire, and subsequent epidemics, 1854 and 1866, furnished only sporadic cases.

In London the cholera of 1866 was very severe only in the east end, which was supplied by the East London Water Company from Oldford. The reservoir is on the river Lee, which is little better than an open excrement and sewer receptacle. Even filtration was often neglected. The consequence was, that the mortality in the district was from 63 to 111 in 10,000, while in the rest of London, supplied with pure water, the mortality was from 2 to 12 in 10,000. London receives now daily 100,000,000 gallons of water from nine companies. A space as large as that occupied

by Westminster Hall, filled with water to the height of 1,070 feet, represents the daily consumption.

Dr. Schiefferdecker reports a fact well worthy of note concerning the six great cholera epidemics which have visited Königsberg from 1831 to 1866, in which 5,543 persons were attacked and 2,671 died. The inhabitants of those parts of the city which were supplied with drinking-water from the river Pregel, and from the wells with pumps, were those chiefly attacked, while those who were supplied by pipes from the so-called upper tank suffered much less severely. This last-mentioned water is exceedingly pure, and remains of about the same composition during the whole year, while the contrary is true on chemical examination of the water of the Pregel and of the wells, which are fed with ground-water. It is probable that the impure river water penetrated into the wells, though it is possible that the contents of the house-sewers emptying into the Pregel found their way also into the shafts of the wells.

Graetzer, in his excellent report of the cholera of 1867, very accurately describes an instance, still fresh in the memory of all of us in Breslau, in which the wall of a badly constructed privy-vault, attached to a newly built and well-arranged house in the New Tauenzien street, rendered the water in the well near to it impure. Besides, the privy-vault was not regularly emptied, and its contents escaped over into a second unwalled excavation in the neighborhood of a large accumulation of ground-water. The consequence of this contamination of the drinking-water was, that in the beginning of the cholera epidemic of 1867, no less than twelve inhabitants of the house were attacked, eleven of whom died, among them the negligent landlord himself. Besides these, also a number of other persons in the vicinity, who simply procured their drinking-water from this house, were likewise attacked. Cholera germs had clearly, in this instance, first entered the privy, then easily found their way into the drinking-water, and so into the digestive organs of the individuals who had used the water, thus engendering in them this most destructive disease.

A great number of chemical analyses of well-water, made in Breslau by Justus Fuchs, as well as the still more important

microscopic examinations of many wells by Ferdinand Cohn, with whom I was myself actively engaged during his life, have proven that, besides the contamination by organic matter, and especially by such matter as results from nitrogenous combinations, a whole fauna and flora live and flourish as parasites in the water of these impure wells. These wells, moreover, correspond quite closely to the houses in which, as a rule, the most numerous attacks of cholera occur, although I know of local epidemics in which the drinking-water was not at fault. The shallowness of the wells, as a rule; their imperfect isolation; their by no means infrequent communication and infiltration with the privy-vaults, water-closet and sewer-pipes in their close vicinity; their abundant supply from impure ground-water—render it easily understood how cholera germs, present in these fluids, may multiply in the most prolific manner. Nevertheless, the conditions favorable to the development of these parasitic germs vary to such degree, that even under the same local circumstances epidemics may be very light or very widely spread. To attempt to deny any influence at all to ground- and drinking-water in the diffusion of cholera, because of these very different conditions, would be a skepticism absolutely unjustifiable. A whole series of positive facts cannot be disproved by negative evidence, which really only shows the variability of the etiological conditions. The history of the lowest organisms reveals to us at every step similar occurrences; the same species of mycetes may now develop in the most luxuriant manner, or again in the same medium entirely cease to exist; this may be due, on the one hand, to the abundance or scarcity of suitable nutritious matter, or, on the other, to the fact that even with an abundance of nutritious matter, the pathogenetic variety may be consumed by other species.

It is very easy, moreover, to misunderstand these conditions, and I have often found that some authors will not admit the influence of drinking-water upon cholera unless it can be considered as the exclusive agent in the diffusion of the disease. Thus Zehnder grants that it is true that a considerably greater number of persons were attacked in the last epidemic at Zurich, who had used the water from the unclean wells, than those who had

used the water from the cleaner wells with spring-water, and yet he ascribes to drinking-water but very little influence. The truth is, nothing acts exclusively in the development of cl olera. The only indispensable factor is the cholera germ ; this acts in every case, from the lightest to the most severe, at every period, in every epidemic, in every land of the earth, and yet its action, too, varies in extreme degree. In many cases it causes but a temporary diarrhœa or a light cholerine, while in other cases it may be fatal in a few hours, the difference depending probably on the numbers in which it has entered, and on the favorable or unfavorable conditions of development it encounters in different individuals. Since, then, all other etiological conditions must first act through this fundamental cause, and since this germ is diffused chiefly by fluids, but may also be spread by the air, by the clothing and bedding, by various emanations and infiltrations, it may be readily understood that there is as much irregularity in the nature of the vehicle of the germ as in the mode of penetration of the vehicle into the recesses of the organism.

Our very worthy Professor of Ophthalmology, Foerster, has recently published a very valuable contribution regarding the drinking-water question and the spread of cholera in the provinces of Posen and Silesia, based on analyses of the water in places that have always escaped attack. Thus the Polish Lissa, a great railroad junction, has always remained free from attack ; its water, which is of very good quality, is brought from outside of the city through excellent pipes. Even imported cases have never extended the disease at this place. Lauban, also, is supplied with pure spring water through iron pipes from without the city, and although a number of epidemics have occurred in the vicinity, it has always enjoyed immunity from cholera. The same is true of Pless, notwithstanding its marshy surroundings. Neumarkt, Grünberg, and Glogau owe their constant escape, according to Foerster, to the same cause. In the fortified city of Glogau, the parts of the town supplied with pipes remained free from the epidemic, even after cholera had been imported ; while the part situated on the right bank of the Oder, which is supplied with water from wells, lost 1½ per cent. of its population in the epidemic of 1866. The same is true

also of Jauer, whose upper eastern portion, supplied by excellent wells dug deep into the rocks, escaped attack, while the western, low-lying parts, supplied by bad, shallow wells, had much to suffer from the disease. Zobten, a town very near to Breslau, likewise escaped. It is but poorly supplied with water, as many of the wells, only twenty or thirty feet deep, but all bored out of the solid rock, dry up during the summer months. Even the privy-vaults here, although shallow, are all dug out of the rocks. During the last few years spring water has also been carried to the city by aqueduct. Tarnowitz also, even after the importation of cases, has always remained free from an epidemic of cholera. I am in possession of the handsomest specimen of petrified shell-fish of all Silesia from this place; also of beautiful lead ore, mixed minerals, also the rare Tarnowitzite; these all lie under the porous dolomite, and must all be penetrated to reach drinking-water. The city possesses also a good pipe-water supply. Foerster attributes the immunity of Schmiegel likewise to the good quality of the drinking-water, as the wells chiefly used are far removed from all privy-vaults, and the layer upon which rests the water is separated from the surface of the ground by three layers of clay. I may add also that in Munsterberg, which has an excellent water supply, cholera has never prevailed. I have often wondered how Pettenkofer, to whom we owe so very much of what knowledge we possess about cholera, could always conduct himself so coldly towards the question of drinking-water, as the drinking-water has in the ground-water one of its chief sources of supply. Pettenkofer has himself published a most striking example of the infection of wells by ground-water, when he announced that he had at times found the ammoniated water of the gas-works in wells situated at a distance of 700 feet. Instances of contamination of wells by ground-water at great distances, from 300 to 500 feet and over, are so numerous that it would be tedious to enumerate them. The importance of drinking-water in the diffusion of cholera is very great, from the fact that it may act independently of the ground-water,—a circumstance which Pettenkofer very justly emphasizes—for instance, by direct infection with cholera germs from privy-vaults, etc. As this infection from

privy-vaults is possible even at the comparatively great distance of 100, even 200 feet and more, it is clear that the incomprehensibly senseless location of wells near to privy-vaults, which is not even now avoided in newly erected buildings, the poor isolation of the wells, the so frequent damage to their structure in cold winters, their neglected or improperly executed repair, easily permit the penetration into the water of contaminated fluids. In this way cholera germs from privies may not only find immediate entrance into the drinking-water after the importation of cases or during epidemics, but they also find the water relatively rich in ammonia, acids, the salts, organic substances, and even the lower organisms, a fluid thus resembling the well-known solution of Pasteur, and peculiarly fitted for the development of cholera germs, if other more innocent parasites have not already so far consumed the nutritious matter as to leave but little for the new-comers. The objection that these most important etiological circumstances are by no means always effective, that their lack of any effect, indeed, may be demonstrated in a series of cases, has no more anti-etiological significance than the fact that of four or five persons bitten by a mad dog,—even with neglect of all measures of prophylaxis, such as cauterization, for example,—but one, as a rule, is infected. Throughout this account, in explaining the development and diffusion of infecting parasitic germs, I have adopted a view which seems to me not only to be in harmony with the facts of natural history, but also calculated on the one hand to refute every exclusive theory, and to show, on the other, that we are not justified in skeptically rejecting facts simply because they are not constant. In unison with Pettenkofer's statement, that the diminution in depth of the ground-water is much more favorable to the diffusion of cholera than its high level, is the explanation that during the period of sinking there is a stronger current towards the wells, while every protracted dryness of the soil, by keeping the ground-water at a low level, hinders the communication between the three factors: ground-water, drinking-water, and sewage fluids.

But however intimate the connection between the ground- and drinking-water, it is of course perfectly clear that if the drinking-water be rendered independent of the qualitative and quantitative

variations of the ground-water by isolation, a most potent element in the dissemination of cholera ceases to exist. The above-mentioned immunity of the cities of Posen and Silesia cannot be due to other causes, certainly not to any geological conditions. Some of these cities are built on primitive soil, so that even granite crops out in their vicinity ; others rest upon limestone, and most of them have a surface of more or less porous diluvium, with the characteristic erratic stone of the far north ; the diluvium is covered with alluvium, beneath it lies the tertiary soil, and only then do we arrive at the older formations. We have thus the most varied conditions of stone formation and soil porosity, so that the immunity cannot be explained on geological grounds. The difference between different parts of cities of no great size, like Glogau and Jauer, could not be explained on geological grounds alone. If it could be proven of Jauer that the lowest part of the city did not enjoy the immunity of the higher parts, entirely aside from the question of drinking-water, this difference of level between the infected and non-infected parts of the city could not be established for Glogau.

So soon as it seems more than probable that cholera germs are of protomycetic nature, the ground-water theory, as an exclusive theory, has the great disadvantage that it overlooks possibilities which are absolutely independent of it. I cite here some of these cases as established by direct observation. The wells of some of the best houses in Breslau, especially those in the Tauenzien suburb, contained bad and impure water, and were therefore little, or not at all, used for drinking purposes. But even the privileged, so considered, thoroughly pure wells contain not a few parasites in their water, which is perfectly clear and of perfectly good taste, and though most of the protomycetes are destroyed by boiling, still some varieties escape. Moreover, the water is not always heated up to the boiling-point in the kitchen. The impure water, not intended for drink, is used to wash up rooms as well as plates, cups, etc. How easy it is for cholera germs, even though fewer in number and further apart than in water not boiled, to adhere to and infect the objects with which they come in contact. The frequency with which washerwomen fall sick with the disease from contact with infected linen has

often been mentioned, but there are also examples where cholera has been spread by rags and other objects. The same is true, in still higher degree, of unclean bedding. Zehnder ascribes the origin of two cholera centres in the Zurich epidemic of 1867 to an accumulation of bedding, mattresses, pillows, etc, which had been used on the beds of cholera patients, and were afterwards piled up, before being carried off for disinfection, in the neighborhood of the houses affected. We have already seen that the air may spread the cholera germs, though not in the measure formerly believed, and hence in a city severely attacked very many persons suffer from a peculiar diarrhœa, evidently due to the influence of the prevailing disease, which is propagated, as already stated, much more readily by moist than dry air. Zehnder especially emphasizes the fact that in the Zurich epidemic of 1867 a moist air, impregnated with gases from privy vaults, found its way into the interior of houses in which the ventilation was defective, and so contributed greatly to the diffusion of the contagion. In many of these houses the privies are in the interior of the building, or at some height above the level of the lower story. In some houses, also, there circulated a current of moist air from the canal into which the privies emptied. It is more than probable, too, that in some cases, owing to insufficient isolation, there was direct escape of infected fluids by infiltration into the neighboring parts of the houses.

Uncleanliness, defective ventilation, and crowding into narrow spaces, very much increase the chances of diffusion of the disease. The cholera germs are not only quantitatively increased in this way, but they find also the richest field for proliferation in the so favorable moist heat and in the fluids saturated with ammonia, which nourish bacteria much more effectively than when a part of the ammonia has already been converted into nitric acid. Each one of the above-mentioned factors is in and of itself injurious, and often those houses apparently most favorably situated, from a hygienic point of view, possess centres of decomposition and infection, the removal of which very much abates or even checks a local epidemic. Although the skeptical tendency exists in recent times to exculpate cholera excretions from any connection with the diffusion of the disease, yet so many facts have accu-

mulated in support of the possibility and frequency of diffusion in this way, that, without giving it anything like exclusive importance, it would be very dangerous to wantonly throw overboard this important etiological factor. And though Griesinger reports that cholera rages murderously among the caravans of the desert of Africa, where there are neither privies nor night-vessels, and the air is unsurpassed in purity, this proves only that privies are not necessary to cholera infection, and that the disease may spread itself without any accumulation of excrement. Yet particles still remain upon the washing and bedding, and excreta may also prove infectious before removal. Moreover, the disease may prevail in unusually different conditions, and it should be ascertained whether the cholera of caravans does not show, as a rule, a much lighter mortality than the cholera of cities and villages. Even though ground- and drinking-water should be withdrawn altogether, yet the power of cholera would be by no means lost; it would only be very much lessened. Pettenkofer long ago maintained this view of cholera in ships, and the subsequent observations of Bryden lent it perfect confirmation. This last author gave statistics of 126 transport vessels, which carried, between the years 1861 and 1869, 50,604 Indian natives from Calcutta to the West Indies. Cholera appeared on 20, that is, 16 per cent. of these vessels, but everywhere in light grade. The same author showed, later, that in 82 vessels which transported 30,361 persons (22,077 to Mauritius and 8,284 to America), but 1 per cent. altogether perished with cholera. All the ships left harbors in which cholera prevailed. If thus, under these circumstances, only one-sixth of the vessels had patients with cholera, and the medium mortality rate was 1 per cent., considering the crowded manner in which the 300 to 400 passengers were com pelled to live in this hot climate, it is a proportion which may certainly be considered as favorable. But here again the drinking-water may be suspected, since although no longer in danger of becoming infected after it is once upon shipboard, yet it may have been brought on board already infected from the land. Anyhow, it would be a very good precaution, under such circumstances, as well as in the provision of caravans with drinking-water, to previously subject the water to thorough boiling.

What changes drinking-water may undergo on shipboard is shown by that mysterious occurrence of dry colic among the French troops on the Senegal; the trouble continued for some time until Chevallier demonstrated that it was simply lead colic caused by the small quantities of lead dissolved in the water which had been stored during the passage in leaden vessels.

Individual predisposition plays an important rôle in all epidemics and in all cases, from the lightest choleraic diarrhœa up to the most well-marked attack of cholera. No insignificant number of persons enjoy at least a temporary immunity against the disease. Should choleraic diarrhœa prevail during an epidemic, many escape it entirely, others suffer only lightly and temporarily, while others again, notwithstanding the employment of all sorts of therapeutical and hygienic measures, are subject to continued and repeated attacks. I was even compelled, on this account, to send a number of my patients away from Paris in 1849. What has been said concerning the immunity of races and nationalities is based, for the most part, on superficial observations. Thus in 1830, or about that time, a certain immunity was claimed for the Jews; but subsequent epidemics showed this to be an illusion. In southern countries, with a mixed population, it is at one time the African, at another the Malay, and at still another the Caucasian race which is attacked. English India is the only country which shows exceptional conditions in this regard. Bryden draws the conclusion, from a series of observations, that of 63,409 Europeans and 93,648 natives in the garrisons and prisons of India, 53.68 per thousand Europeans and 4.11 per thousand natives died, so that the Europeans suffered thirteen times as much as the natives. Most remarkable here, too, was the difference between the Indians of the plains and those of the mountains, representing two different races. It was only the Sepoy regiments, inhabitants of the plains of the Ganges and Central India, that enjoyed a comparative immunity, while the regiments composed of natives of the Himalayas and of the town of Gorkha have pretty much the same predisposition as the Europeans. It is probable, as Pettenkofer remarks, that this difference in

favor of the Sepoys depends upon acclimatization and accommodation, as the new recruits from England suffer also much more severely than the soldiers who have already lived in the country for some time.

It is generally claimed that the dissemination of cholera is independent of *climatic influences*. With the exception of India this is probably true, as a rule; yet this statement should not be made too absolute, especially in regard to the influence of the seasons. From an analysis of 341 epidemics in different lands, Hirsch comes to the conclusion that cholera has appeared in nearly half of all the epidemics during summer, and chiefly in July and August; that autumn and spring are about alike, but that winter is characterized by a remarkable exemption from the disease. The mortality from cholera in the larger countries in individual seasons, as in England during the cholera years 1832 and 1849, is in perfect harmony with this statement. The cessation of autumn epidemics of cholera, on the approach of the cold weather of winter, has been generally remarked. Still, there are exceptions here also; thus cholera continued in Moscow, in 1830, at a temperature of $-4°$ Fahr., and in Orenburg at even $-22°$ Fahr. The highly probable explanation of this infrequency of cholera in winter lies in the fact that moist heat exercises a much more favorable influence on the development of cholera germs and protomycetes in general than a lower temperature.

In India, according to Pettenkofer, the development of cholera demands a medium degree of humidity of the soil. Great and protracted dryness, as well as excessive, long-continued moisture of the soil are alike unfavorable to cholera; therefore it is that in the hot regions of the East Indies, where the dryness predominates and rainfalls are scanty, the cholera breaks out, as a rule, in the rainy season (the summer or monsoon cholera of Lahore); while in the hot regions of lower Bengal, where wet weather predominates and rainfalls are abundant, the cholera prevails in spring seasons which lack their usual rain (spring cholera of Calcutta), and is dissipated again by the summer or monsoon rains. Places like Madras, which stand midway between Lahore and Calcutta as regards rainfalls, other cir-

cumstances being just the same, show pretty regularly a spring and summer cholera in the same locality.

According as the relations of rainfalls and conditions of temperature, of humidity of the soil and of the ground-water vary in any one region from the usual rule, so also do we find variations in the rhythm and frequency of cholera in this region, so that such a place, for instance, as Bombay, has, instead of its usual spring cholera, an exceptional monsoon cholera, and *vice versâ*.

We discover thus what great weight is attached to the monsoon in reference to cholera by the Indian physicians, who are miasmatists; they deny almost all influence to communication, to which the contagionists, as Macnamara, attach the greatest importance. Pettenkofer probably strikes the truth here again when he explains the influence of the monsoon by the saturation of the soil, and accepts also dissemination by intercourse as a very effective agent of diffusion in India.

The spread of the disease by the pilgrims of Hardwár, in 1867, is very interesting in this regard. Three millions of pilgrims assembled here in an infected place, and spread the disease, on their return, over all India; it broke out immediately after their departure, in every place through which they passed on their return journey. Bryden, in denying this influence, expresses himself as follows: "I believe that the geographic distribution of cholera would not have been different had there been no assemblage of pilgrims at Hardwár."

To return now again to the influence of seasons of the year and meteorological conditions, we find, aside from the reports of cholera in severe winters, still another very interesting fact in confirmation of the mycetic theory: cold does not often kill cholera germs, but it reduces them to a minimal, and, for the time, harmless life; but the germs increase again in marked degree, and develop their destructive action with the increasing heat and soil moisture of spring. The cholera survives the winter. So it was in 1849–50 in Halberstadt and several places in Bohemia, whence it spread itself over North Germany and Austria; also in the winter of 1850–51 in several places of Westphalia (Rieke).

The conditions of the weather, aside from cold, exercise but

little influence; still, we observe here too, occasionally, some curious facts. In the Paris epidemic of 1849, after a wet spring, the cholera reached a fearful degree of fatality in the first eight days of June, there being between 800 and 900 new deaths a day; on the 9th occurred one of the most violent storms I ever experienced, and the new attacks at once diminished to one-third of the former number, and continued to diminish from this time on. I refrain from any explanation of this fact, though it made a very lively impression on me at the time. The same observation was reported of the Vienna epidemic of 1849, and likewise of that which occurred in Christiania. Otherwise it has been generally observed, and I can confirm it myself from individual experience, that the variations of epidemics seem to depend but little on the changes of the weather. Rough, changeable, and very windy weather, by producing numerous colds, and very hot weather, in which an excessive quantity of drink is ingested, thus leading to disturbances of digestion and diarrhœa, may act as predisposing causes. Nothing more positive has been obtained from the investigations into the amount either of the ozone or of the electricity in the air. The individual predisposition already mentioned is of far greater importance.

It is generally believed that the male *sex* suffers rather more frequently than the female. This was the case in my cholera hospital in Zurich in 1855, and yet the mortality among females was markedly higher than among males, so that differences may not only occur here in different localities, but the relations of sex also, as regards liability of attack and mortality, are by no means identical. So far as age is concerned, authentic observations show us that the fœtus in utero may be attacked with cholera at the same time with its mother (Mayer, St. Petersburg, 1831; Güterbock, Knolz, p. 11. Most of the children of the aborting pregnant women in the Vienna Lying-in Hospital showed the results of cholera; Buhl and others). At other ages of childhood the liability of attack is very different in different epidemics. Cholera rarely attacks sucklings, as a rule. In the great Paris epidemic of 1849 the disease, in the first three years of life, in the Children's Hospital, was rare but destructive;

after the fifth year it was much more frequent, but still much less so than among adults. The mortality in this second period of childhood was nearly one-half. The second decade of life showed on the average the most favorable results as regards the number attacked and the mortality. Cholera makes absolutely the greatest sacrifice, in point of numbers, between the ages of 20 and 30; but with the advance of years the disposition to it is but little abated, comparatively, although it is somewhat less than in the prime of life; but the mortality increases.

Occupation has of itself much less influence than the bad hygienic circumstances pertaining to poverty, such as severe labor, irregular or often bad diet, frequent excesses, uncleanliness, close crowding, carelessness in regard to drinking-water, privies, etc. Laborers in and about water are said to be more frequently attacked. The influence of the occupation stands in inverse relation to the profits which accrue from the labor; the better the laborer is situated, the easier he escapes. Among the garrisons we have to consider again the conditions of individual barracks, and we notice here a great difference between the infected places with high mortality and those that are free from infection. The same remarks apply to the prisons which, when they are properly kept, are even less liable to attack than other places in the vicinity. An attack of cholera usually protects an individual from a second attack, as recurrence of the disease is not frequent. When an epidemic is of long duration, the inhabitants of the country where it prevails become in a manner acclimated, as in the epidemic centres of India, where the acclimated Europeans are much less frequently attacked than strangers. Everything that reduces the strength of the individual, most especially debility and disease, increases the predisposition; hence the frequency with which convalescent patients are attacked. Besides the not infrequent occurrence of infection in the hospital —a fact observed in the Charité and other hospitals, and concerning which Bryden says that cholera hospitals should be closed whenever the nurses are attacked—I observed in Velpeau's wards the very remarkable fact that all the operations, even the most trivial, were followed during the height of the epidemic by a frequently fatal attack of cholera, so that for weeks every opera-

tion, not absolutely necessary, had to be avoided. The statements that individual diseases lend a predisposition to, or immunity against, cholera, rest on observations which do not justify definite conclusions. Alcoholism, however, predisposes to cholera everywhere.

As regards *diet*, I have always observed that all kinds of nutritious food and drink of good quality may be ingested with impunity during an epidemic, but that excesses of every kind are injurious, and every gastro-intestinal disturbance after imprudences in diet must be carefully treated at once. Of course, during cholera times, as at all times, unripe fruits, decaying vegetables, decomposing meats, drinks of bad quality, are to be avoided with the greatest care. Should diarrhœa occur during the prevalence of cholera, even though in slight degree, the diet, as we shall see later, should be carefully regulated both as to quantity and quality. In several of the epidemics in Switzerland, as also in other lands, more attacks occurred during the first days of the week than the last, on account of Sunday excesses. The fear of purgatives during cholera is carried to excess; severe cathartics should be avoided, but mild remedies, with only laxative effect, as castor-oil, mineral waters, etc., have never proven injurious in my experience; on the contrary, I have often seen in Paris, in 1849, obstinate diarrhœas, which had resisted all other means, yield to small doses of mineral water. Colds, fatigue, very violent mental impressions, may all act injuriously. This is less true of the fear of cholera; as I have noticed, on the contrary, that those who protect themselves most cautiously are seldom attacked.

Nothing can be more capricious than the variation in the intensity of cholera in different places and at different times, or even at different times in the same places. An imported case may end in a local attack confined to a single room or house; even a simultaneous importation of a number of cases at different points may exhaust itself in a number of local epidemics; while at other times a single case suffices to swiftly produce an epidemic, or even a raging pestilence. The history of different epidemics in our large cities shows the greatest variety of effect, according as the cholera germ finds the conditions for development more or less suitable.

The influence of other epidemics upon cholera has been very much exaggerated. The sequence of cholera upon influenza, in the third decade of this century, was a mere coincidence; as was also the precedence of purpura in 1849, in the districts of France, where it was always endemic. Intermittent fever has no particular relation to cholera, though both stand in connection, not infrequently, with the degree of humidity of the soil. As to its coincidence with widespread gastro-intestinal affections, we may remark, first, that the warm summer months favor both, and next, that the prevailing diarrhœa is very frequently the consequence, and not the cause, of the influence of cholera.

In not a few cases the first attacks are isolated, then an interval occurs to quiet public apprehension, and then, after one or several weeks, the epidemic breaks out with violence and rapid diffusion. A light epidemic of long duration may also swiftly and unexpectedly reach a maximum intensity. This course is exceptional, however, and we observe much more frequently that when cholera has once fastened its roots in cities it attains to a considerable height in a few weeks, reaches its acme in the course of the second month, and then either gradually abates or shows one or a series of more marked ascents before its final cessation. The average duration of a real epidemic varies between two and four months, but is more protracted in large cities. I observed that the Paris epidemic of 1849 lasted about ten months; in Prague it continued, according to Loeschner, with six different recurrences, two years and nine months, and in St. Petersburg longer still.

It has been widely maintained that the greater epidemics show comparatively the highest mortality rates at the start, and while this seems to be confirmed in a series of epidemics, it is still by no means a general rule. In Paris and Zurich I saw just as many swiftly fatal and bad forms of the disease, in proportion to the number attacked, towards the close, as at the beginning or in the middle of the epidemic. Very small and insignificant epidemics may also be comparatively very destructive. We had an outbreak of cholera in Breslau during the month of July, 1873, which occurred at different local centres, distant from each other, and which in no way increased to even a light epidemic, as but one or

several persons were attacked daily, and yet at least two-thirds of those attacked died. Griesinger observed the same thing in Cairo, in 1850. I will not deny, therefore, the frequency of a relatively diminishing mortality after the acme of the disease has been passed, but will only call attention to the numerous exceptions.

When the cholera really becomes epidemic, the spread of the disease, even in a severely infected place, is by no means general or in any way uniform. A row of houses or streets, or perhaps the larger sections of a city, become epidemic centres; then again there are in individual houses one or several room epidemics, sometimes with a certain preference for moist cellar lodgings; or individual groups of houses are attacked in one street; often only one side of a street is attacked, or, out of a group of streets, perhaps a square and one or two streets will be visited by the disease, while in the vicinity there will be only isolated cases, or none at all. We find illustrated here, again, the combined effect of importation and of local fixation of the cholera germs in the ground- or drinking-water, in the moisture of walls, in the damp, heavy, musty air of unventilated rooms, and in the emanations of sewers; while the dissemination of the germs is effected by their adhesion to the washing, bedding, vessels, etc. As the most of these local epidemics begin with importation, and as they depend upon the more or less favorable conditions for the development of the cholera germs, they do not last, as a rule, over one and a half or two weeks, only exceptionally much longer, though they are frequently followed later by straggling cases. During my practice in Paris I directed the well-to-do among my patients to leave the house for a few weeks, so soon as a well-pronounced case of cholera appeared in it, and not one of these individuals fell ill later in the course of the epidemic. In the beginning of a local epidemic, therefore, it is sometimes a very useful precaution to vacate certain houses.

The subject of the duration of local epidemics naturally leads us to consider the *period of incubation*. This period usually lasts from two to three days, exceptionally from one to two days; on the average it does not exceed one week, and though a period of one or two weeks is by no means rare, a longer time is exceptional. Cases of very rapid infection, occurring from twelve to

twenty-four hours after the first possible infection, and of which Griesinger cites numerous examples, are encountered relatively much more frequently than those in which the infection occurs late. There are instances of very speedy attacks among persons engaged in cleaning infected vaults. Of course, we only take into account here those cases which have been collected with the greatest care and with every possible avoidance of sources of error,—cases in which it had been carefully noted how long was the interval, first, between the arrival of healthy persons in an infected city and the beginning of the attack, and, second, between the arrival of the disease in a previously healthy city and the moment of attack. The average period of incubation for cases in the first category, according to Pettenkofer's statistics, is 3.6 days; for cases in the second category, 7.7 days. In his work on the cholera in India, Pettenkofer cites new facts concerning the period of incubation; he says the time observed was from two and a half to five days, on the average three days as the minimum period. He cites the observation of Bryden, according to whom, of 611 persons who remained but a few hours in an infected place 10 per cent. were attacked with cholera inside of eleven days—in all, sixty cases, of which twenty-three were grave forms. The first grave case showed itself in three days after infection, on the sixth day the grave cases reached the highest number, and the last grave case occurred on the tenth day. The conditions in the second wing of the same regiment were even worse.

From these facts we may draw a conclusion which is instructive not only in a chronological point of view, but also regarding the whole dissemination of cholera; they show that a local epidemic, whether incidental to the march of troops or localized in houses, is much more under the influence of the first infection than under that of the continued development of the imported cholera germs, and that these localized epidemics, as a rule, cease to increase after one and a half or two weeks, even in a severely infected locality, and thus the local epidemic, which is confined to a small and limited space and a short period of time, is the picture in miniature of the greater and more widespread epidemic which represents and sums up a series of successive local attacks.

Our observations concerning cholera are full of instruction also as regards the natural history of the protomycetes. Ever since the labors of Burdon-Sanderson we have been too much accustomed to look upon the air as in a measure a hindrance to the bacteria. It is true that cholera spreads much more rapidly in the wet than in the dry way; but a great number of facts prove that the germs are also disseminated—without any loss of infectious power—in the dry way, by the air and by adhesion to different substances, and this is the case in still greater measure for the pathogenetic mycetes which belong to the directly infectious diseases, such as relapsing fever, typhus fever, measles, scarlet fever, small-pox, etc. The study of the origin of disease should not confine itself anxiously to the facts in natural history already obtained, but should enlarge and increase them by new investigations.

That the conditions of mycetic development in local epidemics are of paramount importance follows from the fact that these local epidemics not infrequently break out in the seemingly healthiest parts of cities, in houses and streets inhabited chiefly by persons in independent circumstances. I noticed this frequently in Paris in 1849, especially in the Rue St. Lazare. A very strong proof of the possible dissemination of cholera mycetes by the air is the otherwise inexplicable fact of the general occurrence of a peculiar diarrhœa in large cities so soon as cholera has taken root, as well as that other fact that during the prevalence of cholera diseases of the most different kinds may show some of the unmistakable signs of cholera. The relations between cholera and other epidemics do not favor the belief that the one can exclude the other, any more than that they are intimately connected with one another as regards their origin.

SYMPTOMATOLOGY.

The General Manifestations of Cholera.

We include under the term Asiatic cholera the diarrhœas which occur during the prevalence of an epidemic, cholerine, and the well-defined grave forms of the disease. That all three

are expressions of the disease itself, and not simply different degrees of it, is proven by the facts that the simple diarrhœa often terminates of itself without leading to cholera; that the grave forms of cholera not unfrequently begin precipitately without previous diarrhœa; and, finally, that cholerine occurs mostly without previous diarrhœa, frequently does not turn into cholera, and may present, in the most positive manner, all the signs of the graver forms,—only a few of these signs, of course, being present in one and the same case. Some remarks are necessary, therefore, concerning these different conditions.

The *diarrhœa* of cholera has nothing specifically characteristic about it. It has the peculiarity simply that it occurs suddenly in a great number of cases during the prevalence of an epidemic of cholera, and continues epidemic during the whole course of the disease. It occurs mostly unexpectedly, not unfrequently after errors in diet and colds; it is attended with diminished appetite and thirst, but only rarely with a bitter taste and thickly coated tongue. Patients feel weak and uncomfortable; the stools are painless, fluid, tolerably copious, turbid, yellowish or yellowish-brown, contain much desquamated epithelium, triple phosphates, and bile constituents. They are not very numerous, two or three in the twenty-four hours, rarely six or eight, and are attended with borborygmi. They cease of themselves in a few days or in from one to two weeks, but often show a disposition to recur from time to time, during the whole period of the epidemic, in individuals who were neither previously nor subsequently subject to diarrhœa. Some of the real signs of cholera are associated with this diarrhœa, as for instance suppression of urine, cramps in the calves, colorless stools. The impetuous character of the proper cholera diarrhœa is likewise peculiar, but it soon, as a rule, exhausts itself. But as this diarrhœa does not often differ from the common intestinal diarrhœa, every such looseness during the prevalence of an epidemic deserves the greatest attention. There is no doubt whatever that this diarrhœa often leads to an attack of cholera, and therein lies the danger. But this is not only not often the case, but its frequency varies also in different epidemics. While I scarcely saw it fail in Paris in five per cent. of the cholera cases, I have missed

the prodromal diarrhœa in Zurich in one-third of all the cases. The same relation seems to have prevailed also in Munich and other places. An attack of cholera, in which premonitory diarrhœa is absent, is by no means worse on this account, nor has it a less tendency to recovery than one in which it is present. When the prodromal diarrhœa does exist, it lasts on the average from one to three days, more rarely from four to eight, and over.

The *cholerine* which prevails during the time of cholera differs but little from cholera sporadica; it occurs mostly suddenly and unexpectedly, has the character of a violent cholera morbus, and recovery from it is slow. The diarrhœa usually precedes the vomiting at the start. Not unfrequently there are temporary colorless discharges, also violent cramps in the calves, perhaps slight cooling of the extremities, anuria, even albuminuria. I have myself also observed a decided cholerine typhoid after cholerine.

We come now to *the graver forms* of attack, and we observe here, as a rule, that almost every epidemic has its own peculiar physiognomy; that it varies markedly in intensity and extent in different localities; that it often begins with the lighter forms and then passes into the graver, which may then prevail to the end, but it may also present a high mortality from the start. In some cases, it is rather the poor, in others, all classes of the population that are attacked. In many places it lasts a few weeks or months, in others a year and more. In medium-sized or larger cities, in which it has already prevailed, it is but little noticed by the majority of the inhabitants; while in others it snatches away one-fifth or one-fourth of the population, spreading universal terror and horror. In the same city we see some streets and public institutes more than decimated, while in the neighborhood the cheerfulness and frivolity, or the work of the inhabitants, are scarcely interrupted by the individual cases of disease and death. In the same epidemic there is such a complexity in the manifestations and course as can scarcely be exhibited in the most faithful description.

We may regard the diarrhœa, which varies in frequency in different epidemics, as *the prodrome* of the disease. But where

this is absent, patients usually feel depressed, tired, and uncomfortable before the outbreak of the disease. These first manifestations, which may, however, be totally absent, may be regarded as a stadium prodromorum. This stage lasts on the average from one to three days, sometimes longer.

The second stage, with which cholera not infrequently precipitately commences, constitutes the attack proper. It has been designated as the algide or asphyxial stage, terms which are rather one-sided. The beginning of the attack occurs in more than half of the cases in the night, whether diarrhœa pre-existed or not. There is a feeling of stupidity, general weakness, chilliness, most rarely a regular chill, and very soon a tempestuous diarrhœa. More rarely do we observe vomiting at the start or very early cramps in the calves. Dizziness, headache, very great disquiet and anxiety are often present in the beginning, but most patients, it is true, exhibit a certain indifference. At the height of a very intense epidemic we sometimes see cases in which the patients rapidly collapse, with symptoms of great distress, become cold and cyanotic, and die after one or several hours. But in these cases we discover an abundant colorless transudation in the intestine. This form may be characterized as the cholera siderans, but the term "cholera sicca" is highly improper. The first discharges from the bowels are dark and pappy, if diarrhœa has not previously existed; but the bile pigment soon disappears, and they then show the rice-water, whey-like characteristics. Sometimes they are of pale-reddish color from mixture with the blood, and on standing they deposit usually a finely granular, whitish-gray substance, which contains epithelium, shreds of tissue, triple phosphates, bacteria, fine threads of algæ, and blood-corpuscles; sometimes we find also phosphate of lime and crystalloid salts of lime; the fluid is alkaline, contains much common salt and some albumen, but comparatively not a very great quantity. Even in the worse cases the discharges are attended with but little pain and almost no colic; borborygmi and gurgling are frequent. The number of discharges from the bowels varies from three to fifteen or twenty, but seldom exceeds ten or twelve; in quantity each stool amounts to from 4 to 6 ounces, so that, on the average, the material transuded from the

intestines in cholera, during the stage of attack, does not exceed from 50 to 70 ounces. The discharge by vomiting is, on the average, much less. The amount transuded, however, is often not more copious in fatal cases than in those which recover. Still, it is certain that the loss of water from the blood constitutes one of the elements of danger in the disease.

After the violent diarrhœa has lasted one or several hours, seldom before or at the same time, vomiting sets in. The vomiting discharges at first only the remains of the food, but it soon assumes the peculiar whey-like appearance. It is entirely absent in many, even fatal cases; in rarer cases it is reddish from slight admixture of blood. The ease with which most patients vomit is remarkable; it seems almost a simple regurgitation. It occurs in a series of efforts, repeated three, four, or even eight times, and more. The whole period of these tempestuous discharges varies between eight and twenty-four hours, when they become more infrequent and often cease entirely for several hours or even for two days, to return at irregular times—in the case of the vomiting, for instance, especially after the ingestion of drinks. The absence of bile pigment in the stools seldom lasts over twenty-four hours, when the stools again become yellowish-green. But before the stools return to the normal condition there is an irregular variation between a moderate diarrhœa and constipation, unless a dysentery sets in to complicate the trouble. In rarer cases vomiting continues at irregular periods during the next few days. While the digestive organs, the stomach, and bowels suffer especially, other symptoms present themselves also in these parts. From the very beginning the appetite is diminished, so that total anorexia is usually present at the commencement of the actual attack; patients complain also of a pasty or a bitter taste. With the actual attack intense thirst sets in, which is so distressing to some patients that they are compelled to drink continuously, notwithstanding the fact that all drink induces vomiting. The tongue is, as a rule, coated white, and it is only in older individuals and swiftly fatal cases that it early becomes dry; it shows very decidedly the effects of the rapid reduction of temperature, and in bad cases is protruded with great difficulty and much trembling. It

has already been stated that the discharges, on the whole, are not painful, and it is this general absence of pain which permits the patients to easily endure the attack up to the occurrence of cramps; yet there are here, unfortunately, numerous exceptions. The epigastrium is occasionally very sensitive to pressure, and is the special seat of a sense of constriction, a long continued, extremely torturing precordial anxiety with great dyspnœa, the distress of which is momentarily increased by pressure. The abdomen is either flaccid or hard, and drawn in. As in all diseases characterized by frequent vomiting, cholera patients suffer not unfrequently from a distressing hiccough. It has been maintained that in a violent attack the secretion of urine ceases as early as the period of discharges. But it is difficult to prove this statement, and then the more attentive patients assure us at times that in the beginning the urine escaped with the discharges from the bowels, so that the quantity could not be noted. Still, it is undeniable that suppression of urine occurs early in some cases.

Very distressing and painful *cramps* occur, as a rule, after a few hours or in the second half of the attack proper. In the Zurich epidemic cramps were not present in one-third of the cases; but usually they form one of the most tormenting symptoms of the disease. They affect particularly the lower extremities, the calves of the legs and feet, more rarely the hands. As a rule they belong to the attack proper, or cease at least in the course of the second day; but I once saw cramps in the flexors of the fingers up to the eleventh day.

The *fall of the temperature* is no less characteristic of the attack than the cramps and tempestuous discharges; hence the term *algid stage*. It occurs usually in the second half of the attack. The extremities, especially the hands and feet, at first become cold, the hands earlier, probably because the feet are protected for some time by the heat of the bed; then the face, especially the nose and the tongue. The patients themselves complain but little of the cold, which now gradually spreads over the whole body; exceptionally there is a feeling of icy coldness, which is more perceptible to the touch than by thermometric observation, on account of the coincident moisture of

the skin. In Zurich we never saw the temperature fall below 93.5° Fahr. in even the worse cases; once only was it 88° Fahr. in the axilla. The skin loses its elasticity at the same time, as is evident from the permanence of its folds. Should the patients not die in a short time after the attack, the temperature soon approaches again to the normal, but continues variable for a long time in bad cases; in other cases the skin may become warm, and even sweating is not a rarity. So soon as the temperature is once fully restored there is no new reduction below the normal grade. The cold parts—face, hands, feet, etc.—become livid, cyanotic, and collapsed, if this condition persists; the features are pinched, and there is a remarkable sinking of the eyes. When the disease turns to a fatal termination, the eye becomes dry and the cornea cloudy; there is a mist before the eyes.

But while all these profound changes are taking place in the different parts of the body, there is no *fever*. The pulse, from the start, is rather feeble, and little or not at all hurried; exceptionally only is it as high as 96 or 100. In the course of this stage it diminishes in strength almost from hour to hour, and becomes thready and hardly perceptible in the bad and dangerous cases, or those in which the temperature sinks very perceptibly. The stronger the pulse remains in this stage, the better in general is the prognosis. Even though the pulse can be scarcely felt, the circulation may nevertheless be perfectly restored, especially if pulsation may still be recognized in the larger arteries, as the carotid and crural. In bad cases the failure of the pulse may be noticed even at the heart, and I have seen cases in which the diastole could no longer be recognized, while the systole still continued. Occasionally systolic and diastolic blowing sounds are present; but they are not of themselves of grave significance.

The *respiratory organs* show in this stage the following changes: The breathing in the more intense cases is short, confined, and imperfect, often increased in frequency to 24, 30, or even 40 respirations in the minute, seldom higher. Many patients complain of dyspnœa, which is most especially marked during the period of the violent discharges and at the beginning

of the algid state, and disappears again at the end of this period. Pressure over the stomach usually aggravates it. Cough is scarcely ever observed, and stertor is only exceptionally noticed in the fatal cases. In many patients the motion of the lips only is seen during the effort of articulation. This perfect aphonia may at times yield for a brief moment, especially if the intensity of the cramps causes the patient to cry out.

It should be remarked that all the symptoms mentioned follow each other much more rapidly in children under three years of age than in adults, and generally end in death. All the symptoms, however, may exhibit different combinations and different degrees of intensity, and so establish from the start the difference between the lighter and graver forms, as well as between the numerous transitional grades.

The sequence of the symptoms of an attack of cholera proper are, first, precipitate discharges from the bowels, which soon become colorless, then profuse vomiting of rice-water material. So soon as these have lasted a few hours severe cramps set in, the skin becomes cool and moist, and remains wrinkled, the face collapses and is cyanotic, the pulse becomes feeble, thready, or fails entirely, and the heart-beats diminish in intensity. The voice is weak and hoarse,—the so-called vox cholerica—though the hoarseness may be a special manifestation of the general exhaustion. All these symptoms, when they increase still more in severity, may lead to a fatal collapse. Death is rare in the first twelve hours ; it is most frequent in the second half of the first day. When death occurs on the second day it is really more in consequence of imperfect reaction. Death during the attack is characterized by a strange and peculiar physiognomy. The patient lies with the body of a grayish-blue color, with collapsed features, hollow cheeks, pointed tongue, deeply sunken and closed eyes, in quiet indifference, and only gives evidence of pain from time to time in consequence of the cramps. It is easy, however, to awaken him from this state of stupefaction, when he will answer correctly, though slowly, the questions addressed to him. Notwithstanding the great debility, which makes every motion difficult, notwithstanding the profound prostration which is expressed in every feature of the patients, they still possess

not unfrequently entire consciousness. This was to me one of the most disagreeable impressions of the Paris epidemic, to hear patients in whom the pulse was no longer perceptible, in whom the face was fully cyanosed and cold, still speak with the most perfect possession of all the faculties of the mind. According to Reinhardt and Leubuscher, some insane patients entirely recover sanity for the time being, but the sanity vanishes agair with the occurrence of convalescence, while others remain insane to the end. One such patient, half an hour before his death, adorned his attendants with stars and insignia cut out of paper.

Although, as we have seen, all the symptoms may reach such an intensity in the stage just mentioned that a great number of patients cannot survive them, yet we observe in other cases a *third stage*—the so-called *stage of reaction*—which shows the most remarkable tendency to a restoration of the physiological functions, though certainly with unequal results, as we shall now notice. In the favorable cases, after the patient has remained in the condition mentioned for one or two days on the average, the profuse discharges begin to diminish in quantity. Vomiting or a discharge from the bowels may still continue from time to time, but in less quantity, and both lose the whey-like appearance ; constipation may even be present thus early in many patients. The radial pulse, which before could not be felt or was scarcely perceptible, now quickly regains its strength, and in a few hours is often stronger and harder than in the normal condition ; usually it is also rapid, though seldom increased above 96 or 100. Reinhardt and Leubuscher have often noticed a distinct dicrotic beat. The double heart tones also soon become normal and regular ; the blowing sound synchronous with the diastole disappears. Should a venesection be made at this period, the blood will be found to flow as in the normal condition, but the serum will still be diminished in amount. So soon as the regular circulation is re-established the cyanosis of course disappears ; still, many patients preserve for a long time a peculiar marbled appearance. Heat gradually diffuses itself into the peripheric parts of the body ; it rarely ascends above the medium normal temperature, and a profuse sweat is apt to break out at this period, either naturally or in consequence

of hot drinks. Cramps cease, as a rule, with the beginning of reaction. But the urine continues suppressed in the beginning of this period for one or several days, and always shows albumen so soon as it is again discharged. Respiration remains normal, as the dyspnœa had already been markedly lessened towards the close of the first period. Congestions frequently occur in the head; they are especially violent and dangerous in children. The stage of reaction is in general more intense in children, and of shorter duration than in adults, hence it must be watched with the closest attention. The face under these circumstances is reddened, but unequally, so that it has a spotted appearance. The eyes are congested and lachrymose. Most patients complain of a sense of fulness and heaviness in the head, or of a dull headache either general in character or seated in the forehead or occiput. Roaring in the ears is frequent. Notwithstanding a certain tendency to somnolence, the most enfeebled patients are usually sleepless. At all periods of life, but especially in advanced age, these symptoms of reaction may be imperfect, or may even be followed by a return to the algid stage; still, there are cases which finally recover in spite of numerous fluctuations. This stage may also vary much in duration. It lasts often only twenty-four hours, but may continue two or four days; and cases are not rare in which it is protracted to seven, eight, or ten days. When the convalescence is rapid, the symptoms mentioned yield quickly, and without any disturbance, to the physiological normal state; the appearance of the patient in particular improves rapidly, sleep and strength return, the tongue clears off, the appetite comes back, sometimes even in such high degree as to lead to error in diet and relapse. The discharges still show occasional diarrhœa, but soon become more solid; the very scanty urine becomes again more copious, but still shows for a few days an opalescent cloudiness, albumen, and casts—rarely blood pigment. According to our own investigations, and those of Pohl, which were carried out under the supervision of Reinhardt and Leubuscher, the albumen disappears in from two to seven days. In women metrorrhagias during or in the intervals of menstruation are not infrequent in this stage.

Convalescence now makes rapid progress, so that it may be

regarded as perfect—aside from slight after-pains—in from ten to fourteen days after the beginning of the attack proper. If nearly half of the patients die in the algid stage, in more than half of the rest the stage of reaction goes on to a favorable termination.

But the reaction may be imperfect. The discharges recur from time to time with critical symptoms, the appetite is only partially restored or not at all, thirst continues to be a torture, and the little nourishment taken gives rise to a feeling of weight and distress in the stomach. The tongue also does not clean off, and the taste remains bad, while diarrhœa alternates with constipation; catarrhal inflammations of the urinary and sexual organs delay convalescence, and the mind is not perfectly clear. Patients are sleepless, sullen, and may either fall back into the condition of asphyxia, or secondary and subsequent diseases may manifest themselves, or, lastly, the typhoid state may set in. I shall have something to say further on concerning this state, which I have carefully studied in different epidemics. But it should not be overlooked that the convalescence is delayed, fortunately, in only about one-fourth of the cases that recover, and then the course of the disease resembles the favorable form described, only it is more protracted, more varied, and complicated.

In a still later stage the so-called cholera eruption shows itself. This eruption is at one time of erythematous, at another of urticarial character, or it may show a roseola-like appearance. It differs from the eruption of typhus in that it begins on the hands and feet and spreads out towards the trunk; on the face it is mostly imperfect. The spots and papules may also run together and form a diffuse redness in different places. This eruption usually lasts only from two to four days, of which one or two are taken up with its growth and the remainder with its period of maturity and gradual disappearance. It seldom appears before the end of the first and often not until during the second week. Most of the patients thus affected recover, though now and then a case may die.

We have already at different times called attention to the albumen in the urine, and will only add here the results of our observations during the last epidemic at Zurich. The first

urine, after total suppression, was not passed in the cases under our observation until forty-eight hours after the beginning of the disease. We regarded it as a rule that the secretion of urine would be restored in the course of the third or in the beginning of the fourth day. The first urine passed was, as a rule, small in quantity; in two cases it was bloody, and once it was attended with violent pains about the kidneys. Several hours, from eight to twelve, usually elapse between this first and the second discharge. The specific gravity varied between 1,007 and 1,010. At first there was considerable brown coloring matter present, and on boiling with nitric acid it often showed a light bluish tint (indigo coloring matter). Only once was the first urine somewhat cloudy, but without albumen; in other cases albumen was constantly present, and remained for three or four days, and sometimes longer. The quantity of the albumen varied from a light opalescent cloudiness to an abundant deposit on ebullition. Casts were usually distinctly visible under the microscope, and were occasionally present in greater quantity when the urine had been comparatively but little clouded by boiling. Several times the microscope revealed decomposed epithelial cells, and sometimes blood-corpuscles and uric acid crystals. When the albumen disappeared, the quantity of urine became much more copious. According to the accurate investigations of Lehmann and Volk, which are for the most part confirmed also by Professor Buhl, of Munich, the first urine voided is not only quantitatively small and albuminous, but it contains also traces of sugar, a little common salt, and relatively very little urea; while in the next few days the quantity of urine, as well as its relative quantity of urea and salt, greatly increases, even far exceeds the normal quantity, and then, after some variations, again returns to the normal condition, when the albumen, casts, and abnormal pigment disappear and the specific gravity becomes normal.

The so-called *cholera typhoid* is one of the most common forms of protracted convalescence. Frerichs considers it as a uræmic condition. The following are the most important typhoid symptoms: In the second half, or at the end of the first week, the patient sinks into a condition of great debility, com-

plains of intense headache or of a dull sensation, as if the head were in a vice. At first the face is flushed and the conjunctiva deeply injected; later, the patient becomes pale. Almost all patients complain of vertigo; they lie in a condition of quietude or profound indifference, which may increase to sopor or even deep coma.

In the lighter grades patients answer questions properly, but in the more severe forms the answers are disconnected or else none are given; there is also mild delirium. The nights are restless, excited, disturbed by dreams. Many patients lie with half-closed eyes and open mouth, and their speech is unintelligible. Disturbances of the digestive organs are constant; there is a bad taste, a thick and heavily coated, yellowish tongue, which is sometimes fissured and dried. There is loss of appetite, thirst, nausea, occasional vomiting, constipation or diarrhœa, or both alternately, distressing meteorism and ileo-cæcal pain, especially on pressure; cramps in the extremities sometimes occur; convulsions are rare in children; in adults the more tonic spasms, like trismus or tetanus, are encountered. The urine is albuminous and shows the changes already mentioned; the eruption spoken of above often occurs also in this state. If the disease is about to terminate fatally, the patient sinks into profound coma; the discharges become involuntary, even bloody; the pulse, on the whole not much accelerated, becomes thready; collapse sets in, and death takes place after short agony. If the end is to be recovery, the head becomes clear, the tongue clean, the urine normal, the appetite returns, the discharges are regular, and the patient gradually recovers after a tedious convalescence. In many cases boils and abscesses occur in this period of repair. The duration of the typhoid state varies, in the lighter as well as in the graver fatal cases, between two and nine days, the average being from four to seven.

Among the *complications of the convalescence* or of the typhoid state, which not infrequently destroy the patient, are diphtheritis of the larynx and pharynx, intense bronchitis, pneumonia, pleuritis, dysentery, diphtheritic inflammations of the bladder or female genital organs, and parotitis. In rarer cases there may occur, during the convalescence, a regular

relapse, from which, however, I have myself seen several cases recover. The condition of the patient at the time of the attack is of great importance, from a pathological point of view. When cholera attacks a pregnant woman, abortion often takes place, and when cholera occurs in the puerperal bed the disease is frequently fatal. I had in my own practice a sad case of this kind, in which, notwithstanding the most energetic treatment of the prodromal diarrhœa, the disease continued on uninterruptedly to the fatal end. But I have also seen puerperal women recover from severe attacks of cholera. I observed in Velpeau's clinic in Paris, in 1849, that the most trivial operations, the extirpation of a sebaceous cyst, the puncture of a hydrocele, led to cholera. In the Zurich epidemic of 1855 all my typhoid-fever patients who were attacked with cholera died; one abortive case alone recovered.

It is impossible to describe all the sequelæ and complications of cholera. Where the circulation is so profoundly disturbed, the most multiform local congestions and inflammations are possible.

If we take a glance now at the whole *duration of the disease*, we may allow for the period of incubation from five to seven days, often much less, sometimes longer; then, where prodromata exist, they last, on the average, from one to three days. Next comes the stage of attack, which is at times the second, or at times—when the prodromata are lacking—the first; this stage may destroy the patient in from six to eight hours, or even in less time than this, but it varies, as a rule, even in the bad cases which run a rapid course, between twelve and twenty-four hours.

With the end of the attack begins the stage of reaction, usually at the end of from eighteen to twenty-four hours, and in this phase of the disease the patient either dies from cyanotic asphyxia, or the reaction is perfectly established and the attack proper is happily and definitely over. The stage of reaction may pass into speedy convalescence, which may terminate in the second half of the first week; or the convalescence is protracted, either without further critical symptoms or with transition into the typhoid stage. The typhoid stage, in turn, may lead to fatal or fortunate termination in the last days of the first or in the

first days of the second week of the whole duration of the disease. It is a rare exception for patients to die of cholera after ten or twelve days, or to be affected with long-continued bad sequelæ. As regards the mortality of cholera, we may remark that no one has ever been able to collect all the statistics of the lighter and graver cases, because the lighter cases for the most part escape accurate observation. As to the graver cases, the mortality varies, according to the most conscientious statements, between two-fifths and three-fifths; we may put the average at one-half, but it reaches in some local epidemics, under unfavorable circumstances, especially in the asylums for the aged and for incurables, as high as two-thirds, or even three-fourths. Nearly one-third of the deaths occur in the first twenty-four hours, and about one-half of all the deaths occur in the first two days. In the neighborhood of one-sixth die on the third day in consequence of imperfect reaction, and about one-third in the protracted convalescence and during the typhoid state, after from four to twelve days.

In the favorable cases of cholerine, convalescence occurs in two or three days, sometimes later. In the favorable cases of confirmed cholera, and in half of all cases that recover, convalescence occurs in three or four days. In the other half of the cases which recover, convalescence sets in irregularly up to the second half of the first week. Between the beginning of convalescence and perfect recovery a period of from three days to a week elapses; at all events this interval is necessary before hospital patients can leave the house. The mortality in proportion to the whole population is also very different. In Bengal, Persia, Sicily, and many places of the last European epidemic, one-twentieth, one-seventh, or even one-fourth of the whole population perished in certain localities. In the year 1849, 1,200 of the 5,000 inmates of the Salpetrière fell victims to cholera. The mortality varied in the great epidemics of Paris between one one-hundredth and one forty-fifth; in Berlin between one three-hundredth and one one-hundredth; in Breslau it was over two per cent., and in Switzerland between one five-hundredth and one one-hundredth, so that no grand average can be struck. The duration of the disease, its dissemination, the localities attacked, and the pro-

phylaxis adopted are here of great importance. The mortality is greater among children and aged people than in middle life. It increases as a rule with every decade from the twentieth year, and reaches its height after sixty. It was much greater in Zurich among females than males; but general conclusions should never be deduced from any such facts.

DESCRIPTION OF THE MOST IMPORTANT SYMPTOMS OF CHOLERA.

Intestinal Symptoms.

As the following commentary is intended as a supplementary description of the general symptomatology of the disease, in illustration or explanation of individual symptoms, or groups of symptoms, occasional repetitions will necessarily occur, but they will be avoided as much as possible.

Cholera Diarrhœa.

The most important and most constant anatomical and clinical localization of cholera occurs in the small intestines. Here there are two possibilities: either the often so violent discharges of serum are excited by the central nervous system—the excitement originating, according to some, in the vaso-motor centres—or the primitive irritation originates in the intestinal tract. The latter view is to me the more probable. Like many worms, especially the trichinæ, the protomycetes of cholera also find the chief conditions of development in the small intestine, while those of diphtheria have their favorite seat in the pharyngo-laryngeal mucous membrane, those of small-pox and vaccine lymph in the pustules of the skin, and those of relapsing fever have only been found hitherto in the blood itself. Cholera germs adhere but little to the external surface of the body, hence contagion from individual to individual is much less liable to occur than in the infectious exanthemata, relapsing fever and typhus fever.

It is highly probable that the most prolific seat of infection in cholera is the alimentary tract. The germs pass from the mouth to the stomach, but encounter first in the small intestine,

especially in its lower, lymphatic portion, the conditions most favorable for their own life, though most destructive for that of their host. If but few of the germs wafted through the air from the cholera centres have reached the small intestine, there is for days only the light cholera diarrhœa, which not unfrequently attacks at least ten times more individuals than does true cholera, to which, however, it belongs. It would certainly be just as ridiculous to separate from the disease—with a regard simply for mortality statistics—the lighter and lightest cholera influences and forms, as it would be an unheard-of thing to count only the confluent and hemorrhagic varieties in an epidemic of small-pox, with a complete and systematic exclusion of the lightest, the lighter, and the moderately intense forms.

When the cholera germs have once reached the small intestine, through the air or through fluids, the development of their action depends partly upon the quantity in which they have been introduced, and partly upon the favorable or unfavorable conditions for life and increase they may encounter. In some individuals, doubtless, they pass through without leaving a trace. In others their effect is exhausted in an intestinal irritation of one or several days' duration—in a diarrhœa. In not a few the germs rapidly increase, and now occurs either the grave attack of cholera, without prodromic diarrhœa, or the diarrhœa sets in and develops into regular cholera in a few hours, or in one or a few days. In still other cases again, there is neither a cholera diarrhœa nor a cholera attack, with its colorless stools, but only a moderately violent attack of vomiting and diarrhœa, or cholerine, which scarcely differs from a cholera nostras. But all these forms belong together, each may pass into the other, and each may show, beside the most favorable symptoms, individual manifestations of the most pronounced attack. How probable it is that a swiftly fatal attack is developed from direct irritation of the lymphatic portion of the small intestine by myriads of cholera germs, is shown by the action of arsenical poisoning, which may prove fatal in a few hours, with symptoms perfectly resembling those of cholera. Late in the autumn of 1854 a woman, who had been suddenly taken sick during a criminal trial, entered my clinic, in Zurich. She died in the hospital, after a number of violent, perfectly

colorless, very copious discharges. The autopsy showed swelling of the lymphatic glands of the small intestine, and an immense accumulation of colorless fluid. Clinical examination of the contents of the stomach, by my friend and colleague Staedler, revealed an unmistakable arsenical poisoning. In the summer of 1847 I was told by Louis, in the Hôtel-Dieu, that the Duke of Choiseul, who had been arrested the day before for the murder of his wife, died suddenly of cholera, and he wondered at it greatly, because cholera was nowhere prevalent. Louis was the duke's physician, and was, as is well known, one of the greatest diagnosticians of our time ; nevertheless it soon turned out that the duke had poisoned himself with arsenic.

To return now to cholera diarrhœa and cholerine during the prevalence of an epidemic, our attention is arrested at once by the very great dissimilarity presented in different epidemics. I am also inclined to believe that cases of prodromic cholera diarrhœa are more frequent and more widely diffused in malignant and extensive epidemics than in those of less extent. In the great Paris epidemic of 1849, which numbered about ten thousand victims, the prodromic diarrhœa was absent in from five to ten per cent. of the pronounced cases of cholera, while I observed it to be absent in Zurich, in 1855, in one-third of the pronounced cases ; and yet no conclusion could be drawn from this circumstance as to the course of the disease. On the whole, prodromic diarrhœa was absent in just as many cases of those who subsequently recovered as in those who succumbed to the disease. I found that, during the prevalence of cholera, the prodromic diarrhœa was absent in seven-eighths of the cases of true cholerine (with colored stools). In Paris, as well as in Zurich and Breslau, in 1866 and 1867, I saw a number of cases of diarrhœa, which were due to the influence of cholera, recover without treatment, and without subsequent cholera. On the other hand, I observed, in July and the beginning of August, 1866, such obstinate and violent cases of cholera diarrhœa in the Breslau garrison of cuirassiers, where I had charge of a large ward of wounded patients, that it required heavy and quickly repeated doses of opium to prevent an outbreak of cholera. There is no marked distinction, it is true, between common intestinal catarrh and cholera diarrhœa, yet the

latter has many peculiarities. Its inception is mostly sudden and unexpected, often excited by colds or errors in diet. Loss of appetite, thirst, indigestion, are either absent or present in only slight degree; patients feel extraordinarily feeble and uncomfortable, considering that the diarrhœa is neither frequent nor copious. There is nothing specially peculiar, however, in the character of the fluid stools. Often there are but from one to three in the twenty-four hours, during the day or night, more rarely from six to eight or more; rumblings and gurglings are very distressing to most patients. In some cases the diarrhœa lasts only one or a few days, in others, with interruptions, from one to two weeks. In some individuals who have not previously suffered with intestinal catarrh, the diarrhœa returns frequently during the whole course of the epidemic, and then ceases entirely after it. Even in the milder cases of cholera diarrhœa we sometimes observe individual signs of cholera of temporary duration, as suppression of urine, light cramps in the calves, colorless, rice-water stools, which occur, however, more frequently in cholerine. It is not a rare occurrence, either, for a cholera diarrhœa, which remains in other respects without danger, to suddenly increase in virulence, with violent, quickly repeated stools, as in true cholera, and yet cease quickly and be followed by recovery.

The duration of the prodromic diarrhœa, in cases of real cholera, as subsequently ascertained, does not exceed, as a rule, three days, but may continue five or even eight days. I give here a table of thirty-five cases, closely observed in this regard during the Zurich epidemic of 1855:

Duration of Prodromic Diarrhœa.	Died.	Recovered.	Total.
1 day	1	7	8
1 to 2 days	3	6	9
3 days	4	5	9
5 "	1	1	2
6 "	1	1	2
8 "	1	3	4
3 weeks	1	..	1
	12	23	35

Cholerine.

I repeat once more, that the cholerine which appears during the prevalence of a cholera epidemic is only a mild form of cholera, a statement which finds additional support in the fact that some of the grave symptoms of cholera are often associated with cholerine. According to the histories of cases which I have collected at different times, a diarrhœa lasting from one to three days preceded the attack of cholerine in one-eighth of all the cases. Cholerine, is, on the whole, a condensed picture of a true cholera attack in its mildest form. Malaise, headache, weariness of the limbs, diminution of appetite, precede it for one or two days, or at least twelve hours. The attack of cholerine occurs generally in the night. Patients sleep with discomfort, are restless, and are then suddenly awakened by the necessity for a stool. Copious, yellowish-brown, almost watery discharges follow each other at short intervals, to the number of three, four, eight, or even twelve and more, until in many cases where the discharges are very numerous they become at last colorless and like rice-water. During the very first operations patients complain of fulness and tension in the præcordial region, with nausea; soon afterwards vomiting occurs, at first of the remains of the food, then of a yellowish-green, very fluid, bitter or sour substance. It is thrown up not unfrequently by an easy regurgitation, and its great quantity at once reminds one of the vomiting of cholera; it may, indeed, at last become colorless and whey-like, and show a deposit very much like bruised grains of rice. The vomiting is repeated quickly, four or five times, then becomes more infrequent, less in quantity, and ceases altogether in a few hours. The patients, who have in the meantime become very much reduced, now either recover rapidly, or the inclination to diarrhœa continues for some days, with lack of appetite, meteorism, occasional colic, rumblings in the abdomen, and sometimes even with continued inclination to vomit, especially after the ingestion of food. At the end of the attack, or after it, there are in many patients very distressing cramps in the calves. I have also seen moderate cooling of the extremities. I myself almost entirely lost my voice for twenty-four hours

after a violent attack of this kind, and only perfectly recovered it again after several days. I have noticed also considerable reduction in the quantity of urea for several days after an attack, as well as the temporary occurrence of albumen and casts in the very scanty, dark urine. Catarrh of the stomach not infrequently interferes with convalescence, and errors in diet may even lead to a relapse. In other cases, temporary typhoid symptoms manifest themselves, such as headache, vertigo, roaring in the ears, cloudiness of vision, great debility, sopor, etc. Recovery may take place, therefore, in a few days, but it is often not perfect for one or two weeks. It is interesting to note that I have frequently seen this cholerine in houses and families in which, in the course of a few days, cholera broke out in its worst algid, asphyxial forms; cholerine may, indeed, in exceptional cases, lead to the genuine, even fatal cholera. Cholerine may be fatal to aged persons.

Discharges of true Cholera.

The violent, quickly repeated, copious, watery, and colorless stools are quite characteristic of cholera. The fact that they cannot be perfectly retained towards the end of an attack is not of very great prognostic value. The stools differ in color, being sometimes lightly mixed with blood; they also differ in the amount of deposit and the condition of the cells they contain, these being at one time in good preservation, at another in a state of rapid disorganization. Bacteria are present in great numbers, as also masses of zooglöa, but they are as little peculiar as the small parasitic threads found in all discharges. As in dysentery, there is no fæcal odor to the stools of cholera, and I have never been able to discover the seminal odor described by authors. The immense quantity of fluid, very poor in solids, salts, albumen, etc., found in the intestines on autopsy, explains the marked consecutive thickening of the blood, from which a relatively great quantity of water has been withdrawn in a short time. Blood is not only found in the beginning of the attack mixed with the stools, but it may appear later, in the typhoid state, as a consequence of a diphtheritic colitis; but then the

stools no longer resemble those of the attack proper. In many epidemics there seems to be a certain relation between the quantity of the discharges and the gravity of the disease, but I have seen numerous exceptions. Stools but little tinged with blood are not of bad import; when deeply tinged, they are, of course, of graver significance.

A still undecided and frequently discussed question is the significance of the violent and copious discharges as regards the pathogeny of the disease. The anatomical changes, the hyperæmia of the mucous membrane, the distention of the mesenteric veins with thick blood, the ecchymoses and hemorrhagic suffusion of the mucous membrane, the swelling and very great softening of the lymphatic apparatus of the small intestine, are, I am convinced, not the cause of the rice-water stools, but are, with the stools, the effects of a vast development of cholera germs, which intensely irritate the lymphatic portion of the small intestine and excite a rapid hypersecretion, like poisoning by arsenic and other metallic salts, and like the action of the very severe drastic purgatives. The view defended by Griesinger, that the rapid and active transudation from the intestinal mucous membrane and the different catarrhal and dysenteric affections may be excited through the condition of the blood itself, has, it is true, much in its favor; the infection of the fœtus with cholera through the mother, for instance, lends it support. But when this author entirely rejects the local action of cholera germs, he goes, in this respect, I believe, too far. He supports his view also by the fact that the metallic poisons, which may directly irritate the intestines intensely, act in the same way when injected into the blood. But their action in this way is, as a rule, very much reduced. It may be granted, however, that the absorption of numbers of cholera germs into the blood may greatly increase their local irritation of the intestine. But the view which regards cholera as only a violent hydrorrhagia, with thickening of the blood, is as much strained as the older neuropathological, electrical, and other hypotheses. Much obscurity still hovers, however, over the effects of cholera on the whole organism, an obscurity which can only be cleared up by accurate clinical, histological, and chemical analyses. According to our

present histological knowledge, besides the thickening of the blood, we find the different tissues and organs undergoing degenerative processes, which not only produce grave disturbances, but also introduce into the organism from the degenerated tissues injurious products of metamorphosis. Nothing is more instructive in this regard, perhaps, than the tolerably constant participation of the kidneys in the cholera process, and the manifold effects resulting therefrom.

The Vomiting

of cholera patients is something very peculiar; it occurs usually after the first discharges, and the number of the attacks, as a rule, is not greater than that of the stools, and in fact is often less. The easy, almost regurgitant discharge from the stomach, and the abundance of the clear fluid emptied almost in full stream, are characteristics which occur in no other disease. It is only later, when the proper gastric hydrorrhagia has ceased, that many patients are troubled with nausea, desire of vomiting, pains in the stomach, and præcordial anxiety. The real cholera vomit, like the stools, contains carbonate of ammonia, sometimes urea, and has a neutral or alkaline reaction; it is even poorer in solid constituents than the stools, but contains more urea, according to Carl Schmidt, to whom we are indebted for thorough investigations on this subject. Scanty vomiting or the absence of it characterizes exceptional cases only. The subsequent emesis of the typhoid stage depends partly upon irritation of the stomach and is partly of uræmic nature. The interruption of the function of absorption by the stomach is a fact not to be underestimated; thus, for example, it has been experimentally demonstrated, that when belladonna is taken into the stomach the pupils do not dilate, which does happen, however, if it be injected into the blood. But this suspension of absorption is not to be relied on too much, for, to judge from the effects of medicines, it is very different in different patients. Thirst is very tormenting to patients at first, as the fluids, which they swallow greedily, are for the most part immediately ejected. The pharynx and œsophagus take only an exceptional and secondary part in the consecutive diphtheritic croupous processes.

Symptoms on the Part of the Nervous System.

The cramps of the muscles, the frequency of which varies in different epidemics, belong, above all others, to the most remarkable symptoms of cholera. I have usually observed these cramps in the second half of the attack proper, rarely earlier, so that it is highly probable that the already thickened blood stands in some connection with the cramps, which are always tonic. Besides the cramps in the calves there are, in exceptional cases, cramps in the thighs, the upper extremities, the chest and abdominal muscles, and still more rarely in the face. Each attack lasts but a few minutes, but their frequent recurrence and their great painfulness put them among the most distressing manifestations of the disease. I have seen them last up to the end in rapidly fatal cases; but they usually cease with the progress of the asphyxia, as well as, in more protracted cases, in the cold period, before perfect reaction. Besides the disturbance of the circulation and the unequal distribution of blood in the muscles, chemical changes in these, such as lack of water, impregnation with urea, increased amount of creatine, may all contribute to the relief of the cramps, at least during the rapid chemical alterations, and until the muscles have become accustomed to the changed metamorphosis, and the reaction has begun here as throughout the circulatory system.

The other disturbances of the nervous system, even during the attack, are slight. The prostration is easily explicable by the rapid withdrawal of the juices. At the end of the attack, and after it, there is a relaxation, an apathy which not frequently passes into sopor, although in the lighter cases patients are awakened from this condition without much difficulty. In patients who die in the last half of the first or the beginning of the second day, the sopor increases, so that they fall asleep almost unnoticed, not again to awaken. But I have also seen this apathy entirely pass away, so that patients become colder and more pulseless, with perfect consciousness all the time, and die in this condition. In many patients, besides the so frequent and tormenting cramps, there is an extremely distressing præcordial

anxiety, with a feeling of constriction. Delirium is generally absent, but occurs more frequently among drinkers, and later in the typhoid state, during which it alternates with sopor; in cases of pronounced uræmia it is sometimes attended with convulsions.

As a rule, however, cholera patients really suffer but a few hours, and then only in consequence of the cramps. The violent discharges are usually painless, and after the attack there ensues a profound rest, which rather inclines to apathy than excitement. The expression of the face is, in the beginning, only that of great discomfort, later that of indifference, with sunken eyes, which become in grave cases remarkably dry and dull, and are only imperfectly covered by the lids.

In the asphyxial form there is well-marked cyanosis of the face. Should the disease take a turn for the better, the face gradually regains its fulness and vitality, while in the typhoid stage it exhibits all the characters of the status typhosus, and then, under a favorable course, slowly resumes its wonted expression and appearance. If the disease be not too protracted, the body becomes rather more dry than emaciated; a more permanent emaciation occurs only after a protracted typhoid course.

Conditions of the Temperature and Circulation.

The loss of heat in cholera, after the attack proper, renders the term algid, for the subsequent stage, far more correct than asphyxial. The algid condition occurs in all, the asphyxia only in a series of cases. The cold sweat very much increases the subjective sense of cold to the hand of the physician, who really feels it more than the patient himself. The temperature usually falls only four or five degrees (Fahr.), and only exceptionally as much as nine or ten degrees (Fahr.). The slow ascent of the mercury in the thermometer justly caused Bärensprung to regard the irradiation of heat from the skin as lessened during this period. The low temperature of the mouth and tongue is also quite remarkable. The varying reduction of temperature is more or less dependent on the course of the disease in general, and as it is chiefly caused by the changes in the circula-

tion, it often goes hand in hand with cyanosis. The extremities become coldest, then comes the face, while the body cools off much less, so that measurement in the axilla affords no criterion for the temperature of the periphery. It would be very interesting to take comparative measurements during the algid stage, in the rectum, and in the bend of the elbow and ham. It may be easily imagined from the sense of internal heat, of which many patients complain, and from the fact that the temperature of the axilla and rectum has often been noted to be higher than normal, that in the algid state there is rather an unequal distribution than a general reduction of heat, and that the development of heat is more concentrated internally, where it may, indeed, be increased, while the reduction is most pronounced towards the periphery, and chiefly in the extremities. As in many other severe diseases, there may be here, also, an elevation of temperature on the approach of death, while according to Doyère the exhalation of carbonic acid gas is very much diminished. The temperature continues to rise in many cases even after death, as Davy observed as long ago as 1839, and this observation has since been confirmed in a series of other severe diseases. Dead bodies also cool off slowly.

The danger of the stage of reaction consists partly in the fact that the temperature at one time increases and then at another decreases. Unfortunately, the subjective sensations of the physician have not been verified here by accurate measurements. To draw safe conclusions in such cases, the temperature should be taken hourly, or, still better, a thermometer should be left in the axilla, and perhaps a second one in the bend of the elbow. When the reaction is perfect the temperature becomes quite normal; but it rises if the typhoid stage sets in; the rise, however, bears no direct relation to the typhoid appearance, for the temperature may be either not at all increased, or at most from two to four degrees (Fahr.). Throughout the whole duration of this stage the temperature stands in no necessary connection with the general course of the disease.

Disturbances of the circulation are inseparable from the hydrorrhagic attacks; hence, as we have already remarked in the general description, the marked and rapid reduction of the force

of the heart-beats and arterial pulse, together with a slight but by no means constant acceleration. Irregularity of the pulse is not frequent in the earlier period. The very great feebleness of the radial pulse, which may even temporarily cease to beat, is something quite characteristic, and the prognosis, according to my observations, depends more upon the variations of the pulse during the period of reaction than upon the changes in temperature. As long ago as 1831, Dieffenbach found that the larger arteries, when dissected out, seemed small and lax, with thin coats, and yielded less blood on section than in the normal state. In favorable cases the radial pulse gains in strength after a few hours, but the cases are rare where such an increase in force commences only after the lapse of from twelve to twenty-four hours, reaching the normal in the course of the second day. When the reaction has taken place, the variations of the pulse in the typhoid stage, in regard to force and frequency, show nothing further characteristic.

Notwithstanding the great fulness of the venous system, the distention is by no means uniform and general, nor does it stand in any direct relation to the emptiness of the arteries. The cyanotic hue of the face, the tongue, the hands, and feet, is due, moreover, not only to distention, but also to the temporary dark color of the blood. This changed physical condition of the blood explains, also, the failure of transfusion, which has often been attempted since the time of Dieffenbach, but mostly with very unsatisfactory results.

Disturbances of Respiration

are of themselves of secondary importance, as even with præcordial anxiety and a sense of constriction the normal respiration may be heard. It is really astonishing that the diminished capacity of the lungs to introduce the proper amount of oxygen into the thickened blood of the capillaries, and the interference with the exhalation of carbonic acid, do not cause more frequent and more severe dyspnœa. I am aware that many authors claim it as a frequent condition, but in the cases under my observation it has always been only a secondary element. I might, indeed, even go

farther and state that, outside of the forms of asphyxia, in which the sensorium is early affected, there are but few pathological conditions wherein fatal asphyxia is attended with so little dyspnœa as in cholera. Cholera asphyxia differs so essentially from every other kind of asphyxia, that it is questionable whether this term is applicable to cholera in its usual significance.

Any localized morbid processes in the respiratory organs, even as secondary occurrences, are not frequent, and the claim for a primary lung cholera, which has been advanced by several otherwise good observers, seems to me to be totally without foundation. The secondary diseases of the respiratory organs are bronchitis, broncho-pneumonia, diffuse pneumonia, and, in many cases, diphtheritic fibrinous inflammations of the upper portion of the respiratory tract. These latter inflammations may run a latent course, unless a permanent or increasing hoarseness due to some affection of the region of the glottis, continues to exist after the disappearance of that great weakness of the voice called the vox cholerica. The temporary duration of the vox cholerica is explained by the simultaneous dryness and relaxation of the vocal cords. A strong effort on the part of the patient will often produce again tones, and even distinct sounds, shortly after the attack, if the disease has not been too severe. The weakness of the voice, as a rule, lasts only one or two days.

Organic and Functional Disturbances of the Kidneys.

I have already shown, in my report on the Zurich epidemic of 1855, that discoloration and commencing fatty degeneration may be recognized in the cortical substance of the kidneys of individuals who have died as early as during the stage of attack. But this degenerative parenchymatous nephritis, which is more distinct anatomically the longer it lasts, will not suffice to explain the anuria following an attack, and commencing even during that stage ; for the last cholera stools, during the attack proper, have no longer the least odor of urine. I agree with Griesinger, who attributes it to the great diminution of blood pressure in the arterial system, though I would not like to sub-

scribe to his supplementary statement, in which he declares the disease of the kidneys and the subsequent albuminuria to be due only to the increasing pressure in the venous system. The truth is, different factors conduce to the production of anuria: dryness, diminished arterial pressure, distention of the veins, anatomical changes in the cortical substance, etc. It is easy to ascertain by percussion and palpation of the hypogastrium that the bladder remains empty for days after the attack, and it is of prognostic importance to know that the later the secretion of urine is established after the third day, the graver are the symptoms that may develop from the retention of urea and its transformation into carbonate of ammonia; some of these patients die of exhaustion, and others with the typhoid manifestations of uræmia. We have already fully described the condition of the urine in favorable cases; the accumulated urea is entirely removed in a few days, while the evacuation of the common salt is for a long time scanty, and then only gradually becomes normal. I have often been struck, during the examination of cholera urine, by the great number of large, wavy casts present. Wyss has made a thorough examination of the indigo pigment which I discovered in the urine of cholera in Zurich. If the urine continue to be discharged copiously after the restoration of its secretion, the reaction is very much hastened. But if this do not happen, if the secretion be irregular or be arrested momentarily, typhoid symptoms of bad form are to be feared. When the typhoid state is present, and no urine is discharged, the region of the bladder should be repeatedly examined, as retention, in consequence of the coma, with distention of the bladder, is no rare condition, and in such cases it is a great mistake not to use the catheter regularly. A most remarkable circumstance, and one which has never yet been explained, is the fact that the nephritis of cholera almost never becomes chronic. In all the four years after the epidemic of 1854, in Zurich, I was never called upon to treat one of my patients for chronic nephritis, and among a great number of nephritic patients in Breslau I never found one in whom the nephritis could be referred to a past attack of cholera. But while calling attention to the fact that chronic nephritis does not, as a rule, follow

cholera, I would certainly not deny the possibility of such an occurrence.

Organic and Functional Disturbances of the Skin.

Besides the reduction in the temperature of the skin we observe, also, a very remarkable relaxation of its elasticity, as manifested in the persistence of its folds. This is a condition which is only observed in cholera, while the cold moisture of the skin occurs also in other diseases, as grave peritonitis, etc. The perspiration induced by excessive warmth is of no value, while the abundant sweating of spontaneous occurrence after moderate warmth favors reaction in a high degree. When urea accumulates in the blood in great quantities, it is partly excreted by the skin (Drasche). I have already stated the most important points concerning the eruption, which occurs later in cholera, and have called attention to the varying forms of diffusely grouped maculæ, urticariæ, papulæ, vesiculæ, etc. The exanthemata are chiefly observed in middle life, and their frequency varies greatly in different epidemics. Their prognostic significance is in general favorable.

Symptoms on the Part of the Female Organs of Generation.

The so frequent but seldom very dangerous hemorrhages from the uterus depend partly upon simple distention of the uterine veins, with rupture, and partly upon diphtheritic metritis, which may be continued into the vagina. This diphtheritis may exist alone, or may be associated with diphtheritic colitis, or with pharyngo-laryngeal diphtheria. Miscarriage is very frequent among those pregnant women who have survived the attack. The puerperal bed is also a very unfavorable condition, and cholera proves pretty constantly fatal under such circumstances.

Metastatic Processes.

Suppurative parotitis, suppuration of the larynx, numerous abscesses or furuncles, pyæmia, and general diphtheria, are, on the whole, very rare sequelæ of cholera.

COURSE, DURATION, AND MORTALITY.

During the prevalence of an epidemic of cholera we may observe all the transitions, from a light cholera diarrhœa up to the intense attack which leads to death in a few hours. But aside from cases of cholera diarrhœa and cholerine, we must distinguish, in the real attack, between light and grave cases. This distinction is due less to the character and amount of the discharges, than to the continuance, in light cases, of consciousness, with a distinctly perceptible pulse, only moderate cooling of the surface, and perfect reaction. But I have seen patients, particularly aged patients, succumb to the lighter forms. In the graver cases patients collapse during the attack and die at its end, or, occasionally, even before the stage of attack has been reached. Should they survive the attack, the pulselessness, coldness of the surface, and profound cyanosis are most suspicious symptoms, and even after the reaction has been passed they not infrequently fall into the typhoid state, in which no inconsiderable number of patients perish.

It is remarkable that in many epidemics, and at different times, some of the chief symptoms of cholera may be absent or be less frequent in the beginning than in the course of an epidemic. This is particularly true of the cramps. Then again, very grave cases are observed with slight discharges, while in other cases a speedy reaction sets in after very violent and copious discharges. I saw many children affected in the Children's Hospital of Paris, in 1849, and noticed in them the same variations as in adults; I observed the same thing again during the epidemic at Zurich. Cholera is very destructive among sick people, whether affected with acute or chronic diseases, though it is modified, of course, in some of its features. Effusions in the serous cavities may almost entirely disappear during an attack of cholera, owing to the removal from the blood of its watery elements. The mortality of cholera is of course markedly increased when it occurs in conjunction with other acute or chronic diseases.

When patients survive an attack of cholera, they may either

recover quickly or remain for a long time feeble and sickly without any special malady, though not infrequently they retain for a long time an inclination to stomach and intestinal catarrh. Extreme debility predisposes them naturally to other diseases, which may not be regarded, however, as specially incidental to cholera.

The duration of the prodromes averages, as a rule, several days, but may vary between a few hours and a week or more. The duration of the disease itself, all stages included, is, in favorable cases, from two to five days or a week, but may be of more protracted course if a typhoid state or complications follow. A fatal termination in a few hours is rare; but not a few patients die after the third day from imperfect reaction, or later, during the typhoid state.

The mortality of cholera has been reckoned, as stated, on an incorrect basis. The cases in which cholera infection has shown itself only in the form of diarrhœa or cholerine, have been totally set aside, and even the reported cases, in which there has been a transition from the graver forms of cholerine to well-marked cholera, have been regarded as illegitimate, while only the pronounced cases of cholera, in which the characteristic attack was present, have been counted. Unfortunately, we have no other statistics, as the lighter cases the more easily escape observation because a common effort on the part of physicians has never been organized for the purpose of having them accurately recorded. If every physician would, during the prevalence of an epidemic, keep as accurate an account of all the cases of diarrhœa and cholerine, which do not lead to pronounced cholera, as of the cases of well-marked cholera itself, we should soon have statistics of nearly as much value as those we now possess for small-pox, whose lightest and medium forms may be utilized for statistics, as well as the grave forms; the different cases being divided into statistical groups according to the grades of intensity.

In the distinctly pronounced form of cholera the mortality rate shows very great variations both in reference to the patients themselves, and also as regards the proportion to the whole population. The average rate may be put down as fifty per cent. of

all cases attacked, with a tendency towards a higher rather than lower proportion. As regards age, we have already stated how unfavorable is the period of childhood and old age as compared with youth and middle life. While the mortality may reach four-fifths and more among small children and the very aged, it may fall to half this proportion in later childhood, youth, and middle age. I have never observed any diminished mortality of the female sex, as claimed by different authors; the contrary was true in Zurich, in 1855. Disease, bad hygiene, and especially alcoholism, markedly increase the mortality. Though the mortality is as great in many epidemics at the end as at the beginning, there are, nevertheless, not a few instances in which the comparative mortality diminishes with the reduction in the frequency of attack. The mortality stands in no direct relation, moreover, with the extent of the disease; very light and short epidemics may have a relatively higher mortality than those which are very widespread and long continued. Not a few patients die on the way to the hospital, especially when they are transported from a great distance, as is sometimes the case in large cities.

When the etiological effect is just the same, the mortality is greater according as the hygienic circumstances are more unfavorable, according as the population is crowded in close, unclean, and badly ventilated places. Though cholera and typhus often centre in the same places, I must nevertheless call attention in a positive manner to the fact that very different conditions may prevail for both diseases. The Rose district, a most remarkable centre for typhus in Breslau, never had much to suffer, comparatively speaking, during any epidemic of cholera. I have inquired concerning these conditions in all directions, during my consultation journeys in Silesia and the grand duchy of Posen, and have always found that the predisposition to typhus and cholera may be very different in similar localities. For instance, typhoid fever is common in Kattowitz; but this city has never had much if anything to suffer from cholera. As to the relation of the mortality of cholera to the whole population, nothing very positive can be shown; the proportion may be almost minimal, from one to five per cent., while in a pestilential centre it

may be something fearful. It would carry us too far to attempt to confirm all these statements by more full and comprehensive statistics.

PATHOLOGICAL ANATOMY.

The anatomical lesions of cholera are of peculiar character, it is true, but they are clearly more the consequences than the causes of the disease, so that they possess no pathognomonic character whatever. The lesions correspond, of course, to the different stages of the disease.

The great withdrawal of water from the blood is the cause of the fact that the bodies of individuals who have died in the attack, or shortly after it, resist decomposition to a remarkable degree, and accordingly the changes peculiar to dead bodies are lacking in them. The persistence of muscular rigidity is remarkable, and not infrequently there is for an hour or more after death an inclination to muscular twitchings, which I have noticed especially in the calves, while others have observed it in other muscles. Bodies show also, after an early death—six, twelve, or eighteen hours after the attack—the same cyanotic appearance and the same collapse of the features as in the last hours of life.

The nervous system shows few alterations, even in cases of late death with typhoid symptoms. In cases of death shortly after the attack, the cranial bones and the membranes of the brain are engorged with blood, and a thick coagulum fills the sinuses. Once I found a fresh effusion of blood between the dura mater and the arachnoid. The cerebro-spinal fluid is entirely absent in cases where death occurs at an early period, or is present in only slight quantity, and of almost pasty consistence; but I have often seen it more copious where death has occurred at the end of thirty-six hours ; and where death occurs still later, it may even exceed the normal amount in slight degree. The pia mater loses its marked hyperæmia in a more protracted course of the disease and becomes dry, and once I found it icteric. The fluid of the ventricles remains scanty even where death occurs at later periods. It was only exceptionally that I

saw it increased to two or three ounces (in weight); such an increase I once observed where death had occurred as early as at the end of thirty-six hours, though usually it is not increased until after three days and more. There was no connection between this exceptional increase and the typhoid state. Ecchymoses on the external surface of the brain (pia), or on the internal surface (ependyma), are not rare. Only once did I find small capillary effusions in the pons. Usually, where death occurs early, the brain is well supplied with blood; where death occurs later, it is less so, and sometimes it is even slightly œdematous on the surface.

The circulatory organs and the blood show the following conditions: In early death there is absence of the pericardial fluid, or it is scanty and sticky; later it is normal or slightly increased. The epicardium[1] is almost constantly the seat of numerous ecchymoses, which are most numerous towards the base and posteriorly; it is rare to find them on the parietal layer. They are of the size of a lentil, and may lie singly or in groups. There is much more blood in the right heart, as a rule, than in the left, and in cases of early death it is of a pappy appearance, or consists of a mixture of soft coagula and fibrinous clots; these latter may be soft and gelatinous, or firm and colorless, either of which conditions may be present also in the typhoid stage. Once I found a thin fibrinous clot spread out in the form of a membrane over the whole inner surface of the right ventricle. The perfectly soft, dissolving clots, which are often seen, correspond to no particular stage or condition. In some rare cases there was no blood in the heart at all. Sometimes the clot is continued into the terminal branches of the pulmonary artery, and in cases of early death coagula are found also in the larger veins, and there is great distention of the smaller venous networks. While in Zurich, I made chemical examinations of the blood of patients dying in the typhoid stage of cholera, but they showed no increase either of urea or of carbonate of ammonia as a constant condition; still I should not like to draw conclusions

[1] That portion of the pericardium which lies upon and is attached to the outer side of the heart,—the visceral layer of the pericardium.—TRANSLATOR'S NOTE.

from these individual examinations. Virchow has already admirably described the increase in number of the white blood-corpuscles in the heart clots.

As to the respiratory organs, they are seldom affected in their upper portions, though occasionally secondary diphtheritic and pseudo-membranous processes are encountered. The mucous membrane of the trachea and bronchi is very much engorged with blood in cases of early death, and is often covered, later when there is moderate hyperæmia, with mucus, with which masses of leucocytes are more or less mingled. In exceptional cases I found the glands of the trachea considerably swollen. Ecchymoses of the mucous membrane are not uncommon; but they are much more frequently observed, and in greater numbers also, on the surface of the lungs. In all stages the lungs are deeply engorged with blood, especially in their inferior and posterior portions, and not infrequently œdematous. Purulent mucus in the smallest bronchi—bronchiolitis—and the anatomical lesions of broncho-pneumonia, and of diffuse pneumonia, are conditions sometimes seen in cases of late death, after three, five, or eight days. I rarely found evidences of recent tuberculosis in the bodies of cholera patients in Zurich, though they have been noticed in no inconsiderable proportion of cases in other places. Pleuritis, with sero-purulent effusion, belongs to the later and rarer complications. Hemorrhagic infarctions in the lungs are not infrequent in the later periods.

The digestive organs show little worthy of note in their upper parts. The isolated glands of the œsophagus are sometimes markedly swollen. The œsophagus is cyanotic in the algid stage, and ecchymosed at a later period. I have often found the epithelium detached, and once the lower part of the œsophagus was covered with fibrinous diphtheritic membranes. The stomach is distended, and filled with a colorless fluid in cases of early death, while later it is empty and collapsed. The whey-like fluid in its cavities is rich in albumen, alkaline, and contains many altered epithelial cells and small granules, sometimes also red blood-corpuscles, when it is rosy in color. When death occurs after the third or fourth day, the stomach is found filled with a yellowish-green, sticky, gelatinous, or mucous fluid. The

mucous membrane, at first hyperæmic, shows later numerous ecchymoses and occasional spots of bloody infiltration. When death occurs late, the mucous membrane is covered with an abundant, thick, tough mucus. The spots of softening are probably, in part at least, the effects of commencing decomposition.

The most important changes are found in the small intestine. In cases of early death the peritoneum, especially that covering the intestines, is of a rosy color and dry, or covered with a light layer of sticky fluid. The intestines, in the early periods, contain the well-known rice-water substance, in rarer cases a fluid of a pale red color. Besides flakes of finely granular masses, this fluid contains epithelium, shreds of tissue, etc. In cases of late death, the intestine contains a greenish substance of more mushy consistence, and the large intestine may contain masses of even half solid fæces.

During the attack proper, and shortly after it, the glands of the small intestine are chiefly affected. Brunner's duodenal glands are first attacked, a condition which I found to be constant in Zurich. But the affection of the glands in the lower part of the small intestine is the most characteristic. Both the isolated and agminated glands are markedly swollen and prominent. The isolated glands stand out in relief, their size varying from that of a millet-seed to that of a pea, while the patches of Peyer, which also stand out prominently, are granulated on the surface. The swelling is most pronounced towards the ileo-cæcal valve. Aside from the hyperæmia and ecchymoses in the vicinity, the prominent glands and patches of glands give the surface a pale, milky, sometimes more yellowish appearance. When the follicles are pierced, they empty a whitish-gray fluid with fine granules and cell-nuclei, but without leucocytes. The surface is smooth, for the most part deprived of epithelium and villi, and the swollen glands admit of perfect artificial injection. These typical changes are generally found in the first forty-eight hours, but I have often noticed that the swelling had already commenced to diminish at the end of from thirty-six to forty hours, while in other cases the glands seemed greatly infiltrated even after three or four days, especially when this was the case

with the tissue in their immediate vicinity. As a rule, however, the swelling rapidly diminishes at the end of the second day and in the course of the third. The glands become more flat, somewhat wrinkled, and later, almost granular; they are still prominent, however, though shrunken in circumference, while their color becomes yellowish-gray, later almost slaty. Occasionally a blackish-gray or brown, or brownish-red pigment is noticed, especially if ecchymoses have previously existed. In the second week, with rare exceptions, all swelling disappears, and the glands are left increased in thickness and abnormally colored. In the first period I have often found Peyer's patches converted into a network, with follicles which are fissured as if they had been burst open; and as this condition was present in fresh bodies, twelve to eighteen hours after death, the explanation that it is a post-mortem phenomenon is manifestly incorrect. In cases of early death in some epidemics, Peyer's patches, towards the end of the small intestine, have been found slightly ulcerated, as in typhoid fever. The glands of the large intestine, in cases of early death, are also found swollen, prominent, lens-shaped, or with a reddish opening. They, too, collapse at a later period, and show the same retrograde changes as the glands of the small intestine.

The mucous membrane between the glands, as we have already seen, may share in this infiltration. In the first stage it is very deeply congested, almost cyanosed, with not a few ecchymoses, or with extensive extravasations, so that great patches of the mucosa are suffused with blood. I have noticed this condition more frequently in the colon, however, than in the small intestine. At an early stage the mucous membrane about the glands is also quite often softened, and even swollen by a light œdema. Later, the softening and thinning is confined more to spots, as extensive softening of either the small or large intestine is rare in cholera. The same changes in color, as noticed in the retrograde metamorphoses of the glands, are found throughout the rest of the mucous membrane, though they are less pronounced. I have very carefully pictured all these details in my atlas of pathological anatomy.

The anatomical characters of secondary colitis, of a diphthe-

ritic, dysenteric nature, are seen comparatively often in some epidemics, while in others they are almost entirely absent. The mesenteric glands are quite often moderately swollen, but usually without much infiltration.

The spleen is in general small, rather wrinkled and shrunken, of good consistence, and moderately supplied with blood, though I have several times seen it enlarged in consequence of apoplectic effusions. In cases where cholera complicated a typhoid fever, I invariably found the spleen enlarged. The liver, in speedily fatal cases, is often hyperæmic, and shows also numerous subperitoneal ecchymoses. At a later period it is pale, marbled yellow and red, with isolated islands of fatty degeneration. The gall-bladder is distended, in the first period, with dark brown bile; later, the bile is more of a bright green color, semifluid, and like mucus. Catarrh of the biliary passages, even of purulent nature, occasionally develops as a secondary affection. During the attack the bile is retained, but later, when it is again discharged, it seems to be abnormally constituted during a protracted convalescence or the typhoid state, a fact which makes chemical examinations at this period much to be desired.

The bladder usually shows nothing abnormal. If death occurs in the first two days, it is contracted and empty. Still I have found in it, in exceptional cases, an ounce or more of cloudy albuminous urine, even after the disease has lasted from thirty-six to forty hours. Usually a little urine is found in the bladder in cases of death on the third day, though I have several times seen the bladder empty, even where death had occurred on the fourth or fifth day. The mucous membrane of the bladder takes part also in the general cyanosis in the beginning, but it is comparatively but little marked and of less consequence.

In the epidemic of 1855, in Zurich, I made all the autopsies myself with my assistant, and devoted especial attention to the study of the lesions of the kidneys. These organs may early take part in the process of the disease. Even in cases in which death occurred in from sixteen to twenty-four hours after the attack, I have always observed an increase in the volume of the kidneys. At the same time I found them generally filled with blood in the form of stripes and punctated injections in both the

cortical and medullary substances, and on the surface in more star-shaped and marbled spots, with numerous and thick anastomoses. The superficial intercanalicular vessels and capillaries of the Malpighian glomeruli also shared in this condition of congestion, and ecchymoses in different regions were likewise not infrequent. Even in cases of death in the second half of the first day, I have often found the cortical substance of the kidneys in an unmistakable condition of commencing decoloration, extending even from the surface deep down into the pyramids. I have also often seen the capsules abnormally adherent at this time. The microscope reveals at this early stage a remarkable epithelial proliferation in the urinary canaliculi, with cloudy swelling of the cells, the contents of which, consisting of numerous albuminoid granules, may be dissolved by acetic acid. Now and then I have also found, as early as at the end of the first day, distinct transparent cylinders in the interior of the urinary canals. The kidneys, therefore, are decidedly affected on the very first day of a pronounced attack of cholera.

In the course of the second day I have noticed either the same commencing decoloration or else more marked changes. The hyperæmia now was either confined to spots or was general, with simultaneous decoloration of the canals and cortex; casts were present in great quantity, and pressure emptied from the papillæ a cloudy, albuminous urine containing casts, and not infrequently crystals of uric acid. The mucous membrane of the calyces and pelvis was usually hyperæmic, with injection of the fine vessels. The microscope showed progressive degeneration of the cells. The decoloration had so far increased in the course of the third day as to involve the whole cortex, and granulations were now present; the blood seemed to be very unequally distributed; the surface was uneven and rough, and closely adherent to the capsule. The cells had continued to become detached, the development of casts had gone on, and the fatty elements had increased, and now showed themselves as granules and oil drops in constantly increasing quantity in the epithelium and outside of it, in the interior of the canaliculi, and in the casts. These alterations increased in the typhoid stage as well as during imperfect convalescence. The kidneys, according to many accu-

rate measurements, were from one-sixth to one-third larger than normal, the granulations became more abundant, and the decoloration advanced to the pyramids and even between them. The substance of the kidneys was now softer, could be more easily torn, and was infiltrated with a dirty yellow, fatty, and albuminous fluid. The mucous membrane often seemed thickened. In cases where death occurred late all the signs of resolution were present, and in favorable cases all these grave lesions seemed to disappear, as the kidneys regained their normal condition. Chronic nephritis, caused by or incidental to cholera, as already stated, is rare.

The chemical examinations of the various organs undertaken by Staedeler, in Zurich, in 1855, yielded no special results. Leucin was found in the liver, and small quantities of uric acid in different organs; in the spleen, leucin was once detected; in other cases inosite, uric acid, and much pigment. The kidneys contained comparatively much urea, some leucin, bile pigment, and uric acid, but no inosite.

DIAGNOSIS.

Cholera is a disease which is so well characterized that a mistake in diagnosis could only occur when it is not epidemic, or, if epidemic, in only exceptional cases. Even the gravest cases of cholera nostras do not show the pathognomonic characteristics of true cholera, such as rice-water stools, cyanosis, cramps, marked coldness of the surface, etc., or, if they do, it is only separately and not in regular sequence. In exceptional cases a differential diagnosis cannot be established, at least by the symptoms, but under these circumstances the etiological conditions, such as a threatened or already prevalent cholera, may be perfectly decisive. In regard to poisoning, that by arsenic more especially, more rarely that by antimony or corrosive sublimate, may lead to error. I have already laid down in the discussion of cholera nostras the most important points in the recognition of a toxic agency: the taste of the poisons, the traces which they leave in the mouth, in the pharynx, even in the stomach (antimony pustules), the usually earlier and more

intense vomiting than diarrhœa, the not unfrequent absence of rice-water stools, etc. In rarer cases, chemical analysis can alone decide; such an instance fell under my observation in Zurich. The diagnosis is easier in such cases when the discharges are less copious, are bloody, and attended with tenesmus. The diseases which often have to be taken into consideration in making a differential diagnosis—for instance dysentery, intermittens cholerica, peritonitis, etc.—form such distinct and separate pictures as not to deceive the attentive observer. After a thorough description of the symptoms, the diagnosis is as a rule easy, though in the process of differentiation regard should always be paid to other diseases.

PROGNOSIS.

In discussing the mortality the most important points were brought forward regarding the influence of age, sex, previous health, special character of individual epidemics, etc., and I may refer to this section for the prognostic significance of these conditions.

Cholera diarrhœa may be the only effect of the cholera germs during an epidemic, and may permanently cease of itself. On the other hand, experience shows that it often passes into cholera in a few days, so that it is not to be lightly considered or frivolously treated. A spontaneously ceasing diarrhœa, again, does not give protection, as it may return and lead to real cholera. Cholerine, as a rule, may be regarded with more favor, as, although it may lead to grave forms, it runs usually a favorable course, as a light effect of the disease. As to the real cholera, there are on the average about as many chances for recovery as for death. While youth, health, a robust constitution, increase the favorable chances, these are markedly diminished by the age of early childhood and that of extremely advanced life, by previous bad health, exhaustion, debility, acute or chronic diseases, a dissipated life, drunkenness, etc., and the danger increases in correspondence to the diminution in the power of resistance. Bad hygienic conditions—such as residence in a disease centre, particularly in the first days of

an outbreak, or exposure to intensely active germs, as in cleaning strongly infected vaults—very much increase the danger, even though the individuals so situated are in other respects in good health. Different epidemics undoubtedly show great differences, and the danger is not infrequently less during the abatement of an epidemic than at its commencement and during its increase. I have seen, however, so numerous exceptions to these statements that I would advise great caution in reference to prognosis based upon them. The absence of prodromic diarrhœa is not of grave import when the disease prevails as cholerine, while in an attack of pronounced cholera death is very likely to follow under these circumstances. There are also cases in which the stomach and intestines become filled with the rice-water fluid, and death takes place before or in a few hours after its discharge.

Among the symptoms of grave import are very profuse and violent—especially involuntary—discharges, with rapid prostration of strength, great feeling of anxiety, pronounced cyanosis, shrivelled, cold skin, covered with a cold sweat, very small pulse at the wrist, or none at all, absence of the second sound of the heart, etc.

In the stage of reaction the bad signs are imperfect and irregular restoration of heat, insufficient force and volume of the pulse, troubled consciousness, sopor, continued anuria, involuntary discharges, etc. When the reaction has been established, the development of cholera typhoid and uræmic symptoms are always critical signs. Finally, fatal relapses are always possible, even after a favorable course.

The favorable symptoms are moderate attack, unaffected mind, a fair pulse, even though diminished in force, an increasing subjective sensation of improvement, perfect restoration of the pulse and temperature, and normal condition of the heart. A light typhoid attack may lead in a few days to marked improvement and perfect recovery. I have usually found the cholera eruption a favorable sign in a prognostic point of view.

TREATMENT.

When cholera first appeared in Europe as an epidemic, it was for a long time believed that its spread could be arrested by

shutting up the disease. But when it heedlessly leaped over all the lines of isolation, a general search was commenced for specifics. The number of agents of this kind which have rejoiced in an ephemeral glory is almost legion. The conviction then gradually gained ground that we possess no specifics for most of the acute diseases, including that class which arises from infection, but that prophylaxis, hygiene, dietetics, and a proper symptomatic treatment form the basis of our treatment of acute diseases. So long as this laboriously acquired truth had reference to diseases with a comparatively light mortality rate, it entailed no disadvantage, as the method of expectation within rational limits furnished more favorable results, by its avoidance of useless attack upon a disease improperly regarded as an enemy, than the employment of the older perturbatory methods.

But we come now upon a disease, in Indian cholera, which in its well pronounced, typical, and perfectly developed form slays the half of all persons attacked; indeed even a greater number falls at the extreme limits of life and under unfavorable conditions. It may be readily understood how painful it must be for the physician at the bedside to reconcile himself to the scientific fact of the absence of every certain and specific means of cure. But neither science nor practice has lost anything by the recognition of this melancholy truth. For whole decades of years the efforts of physicians have been unweariedly directed to prophylaxis, to the arrest of the disease in its first and lightest phases, and to the connection which so often exists between a thoroughly scientific etiology and an enlightened system of practice; though very great obscurity still hovers about all these subjects, nevertheless much that is valuable has already been acquired, and we may even now look forward to the time when this fearful Indian guest, that has become only too often and too much at home among us, will be very much checked in its devastations. We are not to be led astray, however, because so much here, as in other departments of medicine, is mere probability, and we may in the meanwhile console ourselves with the reflection that our labors and struggles in this direction belong to the highest and noblest efforts of the human mind.

The treatment of cholera is of a twofold nature, prophylactic

and therapeutic; and it is to the prophylactic part that we shall devote the most of our attention.

Prophylactic Treatment.

We shall discuss here, in order, the questions of general international prophylactic regulations, and general local regulations both before and during an attack, as well as that of individual protection.

International Prophylaxis.

International prophylaxis is directed chiefly to prevent as much as possible the importation of cholera and its dissemination. Notwithstanding the assemblies of eminent men especially versed in the subject of cholera, neither official congresses, as that of Paris, nor private meetings like the earnest and excellent cholera conference held at Weimar, have hitherto essentially assisted an international protection. Absolute exclusion is impossible under the present conditions of transportation, and the attempts made up to this time, though always but imperfectly carried out, have furnished satisfactory results in no direction. During the last thirty years cholera has often regardlessly penetrated through double and triple military cordons. Sea quarantine, too, which is much more easily effected, and by which vessels from infected or suspected places are detained from five to seven days, or even for weeks at a time, where they have come from a neighboring and recently infected harbor, has in no way fulfilled the expectations entertained of it. Still, quarantine of vessels should be by no means abolished. Notwithstanding their decidedly injurious influence, great movements of troops cannot, for tactical reasons, always be avoided in cholera times. The fact that the sanitary regulations for shutting out the disease are so often eluded, militates just as little against their employment as the lack of uniformity in the period of incubation and the transportation of cholera germs by the air and by lifeless objects. A ship may propagate cholera germs through lifeless objects even after a quarantine of weeks' duration. At the same time, all unnecessary travel and commerce, all assemblies of

crowds, as at popular festivals, annual market fairs, processions, pilgrimages, etc., should be forbidden and arrested during the prevalence of cholera. Although the injurious effects, so very often proven, of the great oriental pilgrimages of the Mohammedans and of the Hindoos, continue to be denied by incorrigible miasmatists, all the restrictive regulations adopted with reference to them remain still at the present day perfectly justifiable. When military necessities do not demand it, the most extreme care should be observed regarding the movements of troops from infected or strongly threatened regions, and every temporary summoning of the militia from places and regions in which cholera prevails should be avoided.

If but little can be accomplished by efforts to shut out the disease, let humane regulations be substituted for compulsion; thus, for instance, medical assistance should be provided at border and railroad stations and places where many persons congregate from different regions. This provision should have proper publicity, and attention should be drawn to the fact that arrivals from suspicious places must be treated for every form of diarrhœa, no matter how light. The people should be made to understand also that an outbreak of cholera may be prevented in this way, and that physicians and remedies and means of transport are at the public service at these places. If now disinfection, which is to be specially discussed later, be early and thoroughly practised in these places, the evils may be reduced to a minimum degree.

Prophylactic Regulations for a Threatened Locality.

Though regulations for shutting out the disease may not be possible here, and though, later, isolation of a great number of patients cannot well be brought about, nevertheless great good can be accomplished by adopting energetic measures with the first imported cases. Travellers affected with the disease, and other strangers, should be perfectly isolated at once; due regard, of course, being paid to principles of humanity. The building in which such patients are kept should be well ventilated and thoroughly disinfected, and disinfection should be practised at

all the neighboring railroad and mail stations in any way suspected, especially those along the whole line between the infected and non-infected places. Those first sick among the residents of the place attacked should also be isolated as much as possible, and the houses in which they live should be thoroughly disinfected from the very start.

The threatened place itself should be subjected to the most extensive prophylactic disinfection possible. This is a point of special value, as such a disinfection is infinitely more valuable than the usually imperfect method commenced in the course of the epidemic and then, as a rule, only poorly carried out. Cholera hospitals should be erected in good season for the reception of patients, and suitable vaults for the evacuations constructed, in order to prevent the formation of centres of infection, which favor the wider diffusion of the disease.

We should not wait for the outbreak of cholera before putting the streets, places, yards, and houses in a state of perfect cleanliness. All stagnant waters should be drained away, and all excrement removed from the vicinity of houses; the refuse of the trades, especially the easily decomposing garbage of butchers, should be regularly carried away under police supervision. The results are vastly better when privy vaults are cleansed before than during an epidemic. Thorough disinfection should follow the emptying of the vaults and privy pipes. Especial attention is to be devoted to this point, as it is absolutely incredible to what an extent the accumulation and decomposition of the contents of privies and privy pipes may go on. It is high time that the authorities should devote more attention to the privies, privy vaults, cloacæ, and wells than they have hitherto thought necessary. The wells are too superficial in many cities; they are often damaged, especially in cold winters; they are not inspected; are usually only repaired when the pumps are at fault, and no attention seems to be paid to the good or bad quality of the water. The bad location of wells in the neighborhood of privy vaults, stables, etc., allows an easy communication, in time, with the products of decomposition and the organic substances of the ground-water, as well as with the contents of privies in their vicinity. During the prevalence of

an epidemic, the wells may thus, by atmospheric emanation as well as by drinking, bring the dangerous germs, after intense multiplication, into abundant contact with the human organism. The more generally care is taken to secure a good water supply by conduits from without, with isolation and supervision of the whole system of pipes, the more will this auxiliary to the spread of cholera and many other diseases be combated. The conduit system has the great advantage that it permits, during an epidemic, a great increase in the number of wells and cisterns provided with constantly flowing water. Wells with water of notoriously bad quality should be closed up before an outbreak of cholera, and that without the least hesitation. The dwellings of the poorer classes should be thoroughly inspected at the right time, and all crowding, uncleanliness, bad ventilation, be at once attended to. Places of refuge, to which the inhabitants of decidedly unhealthy dwellings could be sent before the outbreak of the disease, are very much to be desired.

The sanitary police in supervision of food should inspect the markets with most particular care, and confiscate, with penalties, all unripe and decaying vegetables, fruits, potatoes, etc.; the same care should be taken that the meat and its products, especially sausages, when offered for sale, should always be of good quality. Every commencement of decomposition is to be closely scrutinized. The spirituous drinks should be carefully inspected in regard to quality, acidity, adulteration, etc., and the same rule applies to milk. Cities threatened with cholera should be early supplied with ice. The benevolent institutions for supplying better food, the soup-houses, and the relief associations, should all be organized in time. The same is true for the service of nurses, and for the appointment of civic and medical committees, etc. Care should be taken to secure an abundant supply of good material, beds with their appurtenances, dishware, etc. The apothecaries should be strongly forbidden at such times to sell emetic or purgative medicines without a physician's prescription. Disinfectants, of which more in detail later, should be obtained in such abundance that they may be furnished to the poor free of charge. Care should be taken to provide dead-houses, to which bodies can be carried immediately after death.

General Regulations to be observed upon the Appearance of Cholera in a Locality.

So soon as cholera has broken out in a locality the people should be fully instructed as to the proper means of protection. The greatest emphasis should be laid upon the necessity of cleanliness, of good ventilation, and good drinking-water, which should only be used after having been subjected to thorough boiling. There should be no hesitation in entering into details in explanation of these subjects. Attention should be called to the highly injurious effects of food and drink of bad quality, or in commencing decomposition, and especially to the danger of diluting milk with infected water. On account of its possibly being diluted, the milk should always be boiled. There should be no limitation of the accustomed food, when of good quality,—a very common mistake of the pure theorists, who write cholera essays for the people. To throw suspicion on fresh, ripe vegtables, while at the same time roast meat and wine are recommended, would sound like mockery and derision, were it not somewhat excusable on the grounds of thoughtlessness and ignorance of the manner in which the masses of the people live.

Especial instruction should be imparted as to the paramount importance of the prodromic diarrhœa, and the even higher necessity of proceeding against it as quickly and effectually as possible. The people should also be taught how cholera may be spread by the stools of an apparently simple diarrhœa, by the cholera dejections, and especially by cholera linen, for the disinfection of which rules will be given later. Easily comprehended information should be furnished also on the subject of disinfection. All cases of diarrhœa should be referred to physicians and medical bureaus, but warning should be given against the knights with "sure cures," as well as against every form of charlatanism. A well-organized system of benevolence will regard not only the food, but also the sleeping-places, the beds, the fuel, etc., of the poorer classes, and secure the gratuitous provision of the tried remedies for diarrhœa, means of disinfection, etc. The number of physicians for the poor should be increased according to necessity, and assistants supplied as desired. Fixed bureaus

for medical service day and night should be organized and provided with the necessary means of treatment and transport. Committees of physicians and civic officers should hold frequent consultations in common. The practice of making house visits among the healthy should be carried out extensively by laymen, for the purpose of instructing the people more thoroughly as to the means of quickly acquiring the proper remedies, and treating the diarrhœa according to directions previously given (the visitation system). In manufactories, schools, infirmaries, barracks, prisons, in a word, wherever numbers are crowded together, daily inquiries should be made concerning health, and *especially diarrhœa*, and action taken accordingly. This was a system that gave very favorable results in Paris, in 1849. The supervision exercised by the sanitary police over collections of individuals in public or private institutions, may greatly assist the general efforts to secure a strict compliance with the rules in regard to cleanliness, ventilation, drinking-water, food, privies, disinfection, transportation of the sick, abandonment for the time being of pestilential centres, etc.

Cholera hospitals should be so situated as to be easily reached, but yet not in the midst of great centres of population. In Middle and South Europe barracks hospitals might also be erected. When possible, the lighter cases, as of diarrhœa and cholerine, should be separated from the grave cases, and the latter from convalescents. Transportation to the hospital is best effected by portable baskets, and care should be taken to secure the provision of a sufficient number of baskets, carriers, and nurses in season. Such provision will prevent the necessity of too great effort on the part of a few. These baskets, likewise, should be disinfected repeatedly, as also the dishes, night-vessels, beds, washing-rooms, etc., in the hospital. The utmost cleanliness and the most abundant and frequent ventilation are absolutely necessary. The discharges must be quickly removed, mixed with carbolic acid or carbolized soda, and buried, or, according to Küchenmeister, mixed with sawdust and burned. Cholera patients are not to be put with other patients; and the cholera apartment should be as secluded as possible, well ventilated, and carefully subjected to frequent disinfection.

If a centre of disease be in process of development, or if it be already developed, all experience teaches that isolation is not only impracticable, but even useless. No matter how great the precaution, we only succeed in shutting up the wolf in the stall of the sheep. Abandonment for a time takes the place now of isolation. When the anti-hygienic conditions are decidedly bad, the abandonment may be effected by persuasion, or if necessary, by force, which should be employed also, when the danger is great, even among the better classes. Of course care must be taken that the places of refuge are spacious and suitably constructed. Such was the case with the Klingenthal garrison in the Basle epidemic of 1855, where the results were excellent, as also with the music hall in Zurich in 1867.

Besides the storehouses for disinfectants, whence the means of disinfection can be supplied to the poor free of charge, there should be large chambers where the clothes can be washed, and where the bedding, and other materials which have been in contact with cholera patients, can be disinfected under supervision of the sanitary police. But the materials to be purified should not be left long lying in heaps in front of such places. When several cases of cholera have successively occurred in the same house, the wells, and especially the privies, should be closed up. But it is necessary in such cases to establish the *fosses-mobiles* system, movable depositaries for the dejections, as was done in Zurich in 1867, where these precautions seemed to be attended with very good results. According to this plan, the contents of the night-vessels are emptied into buckets in the halls and yards; these buckets are then carried away daily, after thorough disinfection, and fresh ones left in their places. If the privies cannot be closed, they should be regularly disinfected under police supervision.

Disinfection of the linen before washing is absolutely necessary. This may be accomplished by first placing the linen in dry ovens, or by subjecting it to the fumes of sulphurous acid, after which it should be thrown into boiling water and macerated before delivery to the washwomen,—a point to which we shall return again.

When an epidemic is positively developed, regular daily bul-

letins should be published as to its exact status. Concealment or optimistic, therefore untrue, reports are decidedly injurious, while definite statements from the authorities quiet public apprehension. Dead-houses, to which bodies are to be carried as quickly as possible, should not only be properly arranged, but special attention should also be given to funerals. Great processions and long-continued ceremonies may be followed by injurious consequences. The authorities should also provide a sufficient burial corps.

Disinfection during the Prevalence of Cholera.

I confine myself here to the most important points on this subject. Much has been said concerning disinfection, both for and against. Some look upon the cholera dejections as the proper poison-carriers; others regard them as incapable of producing contagion. Some have a blind belief in the protection afforded by these agents against infection, others deny them any value whatever. If any one is disposed to leave the whole course of the disease to chance, because of the differences of opinion concerning not only this, but nearly all the questions of cholera, he would commit a great and most deplorable mistake.

Physicians are almost unanimous in the belief that a specific organic germ lies at the basis of cholera. The opinion gains ground from day to day that this germ is not only organic, but also organized. Whether this germ, which has entered the organism of the individual attacked, directly or indirectly from the earth, water, privies, vaults, etc., is to be sought in the dejections or other emanations or not, physicians are pretty generally unanimous in believing that patients may in some way or other assist in disseminating the disease.

It must be the continual effort of science, therefore, to prevent as much as possible the injurious action of the cholera germs before or after their entrance into the human organism. Convinced of the value of disinfection in this regard, I shall now bring forward the most important points concerning it, from a practical point of view.

Above all things it is essential to make a distinction between

disinfection in treatment and the common antiseptic methods employed in the trades. A much greater quantity of disinfecting material is necessary to destroy actively growing germs than to prevent their development; a series of new experiments have fully convinced me of this fact. The small quantities which suffice to prevent sepsis in solid and fluid foods, by no means suffice to disinfect infected substances, fluids, etc. The work of disinfection is to destroy the germs or lower organisms already developed in considerable numbers; of course, if preventive disinfection has been extensively practised before the outbreak of an epidemic, a decided advantage will have been gained. Another important preliminary point is this: there is a great and not sufficiently recognized difference between disinfection and the destruction of odors. The destruction of odor reaches only a few of the products of fermentation, of decomposition, and infection. True disinfection should reach the cause, the fundamental basis of all these processes.

Who shall take charge of the disinfection? Best the authorities, and in the most rigid way, assisted perhaps, by those who are sufficiently independent in circumstances to be able to share the costs. Disinfection is never so generally and thoroughly carried out by private parties as to be of any real protective effect. But there are numerous instances where large cities have been most successfully disinfected by the authorities.

I will now make a few comments upon the agents of disinfection, taking them in the order of efficiency, and I commence with the best and most potent.

1. *Carbolic acid*, or phenylic alcohol, is the best antiseptic and antimycetic agent of all the well-known and thoroughly tested means. Water which contains carbolic acid in the proportion of two per cent. will destroy great quantities of protomycetic masses. The pure acid, unmixed with any of the numerous substances suggested, is by far the best, and most to be recommended. It is comparatively costly, but is more reliable than any of the cheap disinfecting substances. Its permanent odor in houses and dwellings is disagreeable, but one soon becomes accustomed to it. For large accumulations of excreta, privy vaults, etc., from six to eight ounces of the acid should be

dissolved in as many pints of water, and the solution poured in once a day, best with a watering-pot. For water-closets, from three to six ounces suffice; for large night-receptacles, from an ounce to an ounce and a half a day, and for ordinary *pots de chambre*, during the stage of attack, a few scruples, to be poured in from time to time. The floor of the room should be sprinkled every day with a two per cent. solution, for the purpose of destroying the germs that may be floating in the air, and if the room be always moist, the solution may be mixed with sawdust, which should not be made too wet, however, and then, after strewing the floor with it, the room should be swept out or cleaned up. The washing may also be sprinkled with the same solution before it is put into boiling water. The heat of an ordinary baking-oven, raised to 212° Fahr., should be employed for disinfecting the linen, which will not bear boiling water, and this dry heat is also the chief means to be used in the disinfection of mattresses, garments, etc. As regards less valuable materials, such as straw beds, etc., it is best to burn them up, and one should not be too economical in this particular in cholera times. Küchenmeister's suggestion to burn up the excreta with fine and dry sawdust, is especially to be recommended.

2. *Sulphurous acid* has hitherto found but little application in cholera, although its fumes have long been employed in numerous ways for the destruction of parasitic germs and organisms. As vaults, privies, vessels, etc., cannot be disinfected with pure sulphurous acid, I have made a series of experiments with water impregnated with two per cent. of the acid. Even an excessively weak solution, as one part to ten thousand, suffices to arrest the development of protomycetes, though a two per cent. solution is necessary to destroy them when already in active growth. This solution remains for weeks without any alteration in the degree of oxidation of the sulphurous acid. Its penetrating odor is only transitory. It is easy to make large quantities of a solution of sulphurous acid, varying from two to five per cent. in strength, and it is cheaper than any other disinfecting agent. From two to several pints of this fluid may be used daily for vaults and privies, and from one and a half to three ounces for night-stools and small vessels. Disinfection of

the washing and bedding material may be accomplished by the development of fumes of sulphurous acid from burning sulphur in perfectly close rooms, after previous sprinkling with the solution mentioned. My suggestion, that water impregnated with sulphurous acid should be used in somewhat the same manner as Lister's bandage, for the purpose of destroying bacteria, or of preventing their development in wounds, has not been subjected to the test of experience. My experiments with it, however, justify the hope that we may possess in it a potent, cheap, and easily applicable method of disinfection for a wide range of cases.

3. *Green vitriol*, the sulphate of iron, had at one time a great but only ephemeral reputation as a disinfectant. We have become convinced, however, that it is more potent in disguising bad odors than in energetically attacking the growth of parasitic germs. Its oxidation of organic compounds does not lead to the destruction of injurious mycetes. The more this agent was used, the more numerous became its combinations with carbolic acid, permanganate of potash, etc., a proof that its universal antiseptic action has been more and more distrusted.

4. *The Permanganates* develop a rapid but quickly vanishing disinfectant and germ-destroying action, hence it has been recommended in multiform combinations with sulphate of iron, chloride of lime, etc. I cherish a distrust against all compound disinfectants, as it seems to be imagined that any uncertainty of action on the part of individual substances will be relieved by a multiplication of agents, or by chemical combinations ; theories which rest, for the most part, on uncertain or obscure conceptions.

5. *Chloride of lime* is one of the oldest, but certainly not one of the best disinfecting agents, notwithstanding its continued officinal character. It destroys bad odors, but affects but little the germs and seeds of parasites. Its fumes, if developed in sufficient quantity, are, at most, only partially destructive to parasitic germs, and besides being disagreeable, they are even at times injurious.

The same uncertainty of action pertains to *Süvern's* disinfectant, which consists of a mixture of lime, magnesium chloride and tar, and of lime and coal.

Carbolic acid is therefore the best means hitherto known for

disinfection of the air, of excreta, sink holes, and privies. The efficacy of sulphurous acid water remains still to be proven. A boiling heat is the best method of destroying the dangerous germs in drinking-water. The washing, bedding, and clothing are most thoroughly disinfected by fumigation with sulphur or sprinkling with a carbolic-acid solution; or it may be accomplished by dry heat in ovens and by maceration in boiling water, when the quality of the material will admit of it.

Individual Protection.

It is generally believed that the fear of cholera predisposes to it. My experience does not confirm this view, as I have found that the greater the fear, the more minutely are all the precautionary measures carried out. These precautions are, above all things, of hygienic nature, and the apparent effect of preservative agents depends upon the well-known affinity existing between charlatanism and credulity. The most carefully regulated hygiene plays here the chief rôle: avoidance of colds, disturbances of digestion, errors in diet, excesses of every kind, mental disquietude, in a word, the observance of moderation and caution in everything. The accustomed mode of life, if normal and rational, should be by no means changed. But the vegetables which are rich in water, and might for this reason easily induce diarrhœa, as for instance cucumbers, melons, etc., should be taken more cautiously and in less quantity. Of course all unripe vegetables, or those commencing to show signs of decay, all drinks of not perfectly normal quality, are strictly to be avoided. A good animal diet should be ordered for feeble and sickly patients, with old wine, and the addition of a little rum or cherry water to the tea; the feet and body should be kept warm by flannels, if the circumstances of the individual permit these comforts. Among the poorer classes small quantities of brandy may take the place of the wine, and where the diet cannot be substantial, good, warm, nutritious soups and hot coffee may be recommended. The physician must of course regulate his advice, especially in cholera times, according to the circumstances of his patients. It is on this account that

soup- and other eating-houses should be carefully organized on the most extensive scale possible before or at the beginning of an outbreak of the disease. Thorough, regular, and abundant disinfection is an important factor in individual protection. Useless contact with patients, or unnecessary visits to houses where cholera prevails, should be avoided, unless it is a case of near relationship, or unless the individual, on account of his vocation or from motives of philanthropy, is willing to expose himself to danger. Among the most important suggestions for individual protection is the advice to treat properly, or have treated, every form of diarrhœa, no matter how light. I learned the exceeding value of this and other prophylactic suggestions in a large practice during the fearfully murderous epidemic of Paris, in 1849. There is no time when the physician may prove himself a friend to the family in such degree as during the prevalence of an epidemic of cholera.

When a number of cases have occurred in a house, the remaining inmates should be advised to leave it. The poor should go to the previously arranged houses of refuge, the wealthier to a residence in another part of the city, or to another place in the country for a few weeks, but always carefully armed with instructions how to avoid contracting the disease in the places visited. All who are very fearful of the disease, and who may be able to leave the infected locality, should do so as early as possible, alone or with their families, but always instructed of course as to the best means of prophylaxis.

TREATMENT OF CHOLERA IN ITS VARIOUS PHASES.

Treatment of Cholera Diarrhœa.

Although it is true that many cases of diarrhœa during the prevalence of cholera are spontaneously cured, and although cholera diarrhœa has no distinctive features, nevertheless there can be no doubt that every case of diarrhœa in cholera times should be treated immediately and energetically until fully arrested, and this treatment should be at once instituted anew with every appearance of the diarrhœa during the course of the epidemic.

When we attempt now, as has been done in a large and very valuable hand-book on pathology, to recommend to a patient, who is usually not sick in any other way, "rest in bed at once, fasting, or the ingestion of the lightest and simplest food," etc. we may expect to encounter opposition and disobedience every day. Comparative rest, caution in diet, small quantities of light animal food, red wine as a drink, flannel bandages about the abdomen, all assist treatment, it is true, but they only possess an apparent and decided influence when the diarrhœa is inclined to cease of itself. Opium is the sole and only agent that has in general a real preventive character in cholera diarrhœa, and especially in the more intense and obstinate forms. Legion is the number of agents recommended; but in almost none, even in the most complicated, is opium lacking. The effort has very properly been made to overcome the other effects of opium, constipation, interference with gastric digestion, diminution of the appetite, stupor, etc., by exhibiting it in smaller doses, in combination with astringents, as catechu, tannin, nitrate of silver, extract of rhatany, etc., or with strychnia, subnitrate of bismuth, etc. Its preparations have also been extensively combined with nervines. Such combinations, when prepared according to the demands of individual cases, are not only justifiable, but also exceedingly efficacious. But it is essential to have some special formula for general use, which may be sold at the apothecaries without a physician's prescription. It is further necessary that all sanitary bureaus and even laymen in charge of large manufactories, educational institutes, bodies of troops, etc., should have these remedies ready for immediate use so soon as any one of their employés or subalterns is attacked with diarrhœa, either for the first time or anew. I have made extensive use in such cases of the following pills:

℞. Argenti nitratis..... gr. ix.
Solve in aquæ destillatæ.... q. s., et adde,
Extracti opii..... gr. ivss.
Pulveris althææ..... gr. xxij.
Extracti gentianæ..... q. s.
Misce, et fiat massa in pilulas xxx. dividenda.

Let one of these pills be given two or three times a day in

cases of light diarrhœa, and two pills three times a day in the more severe and obstinate cases. But should the stools follow each other rapidly, I administer two or even three pills every hour until the diarrhœa yields. After the cessation of the diarrhœa, I advise those who are strongly predisposed to it to take one pill every evening for several days.

I have also used with advantage a mixture of two parts of paregoric to one of wine of opium, giving from nine to fifteen drops several times a day in the lighter cases, and fifteen drops in a teaspoonful of sweetened water every hour in the more frequent and violent diarrhœa. When the cholera diarrhœa is more obstinate, I prescribe a powder containing a third of a grain of opium, and either three grains of tannin or eight of subnitrate of bismuth, with eight of sugar. In very obstinate cases, such as are observed in infected houses and streets, and at the height of epidemics, I assist the internal administration of these remedies by injections of from one and a half to three grains of nitrate of silver, with from ten to fifteen drops of laudanum, in three ounces of water. If the first injection is quickly passed, a second should be given shortly after; in urgent cases I order two such injections in twenty-four hours. In cases threatening great danger, I give fifteen or twenty drops of the tincture of opium at once, and then follow it up with smaller doses. In cases of great nervous distress and anxiety I have used with good results, besides the above-mentioned mixture of paregoric and wine of opium, equal parts of laudanum and spirits of camphor, in six to ten drop doses. For the pains and colic I let the patient drink warm chamomile tea, while at perfect rest in bed, and apply poultices to the abdomen or cold compresses covered with a dry cloth; when these compresses remain on the surface for some time they soon become warm and make the best warm applications. Should the diarrhœa return in spite of all caution and treatment, the patient should be advised to change his location. Mild laxatives, as a teaspoonful of castor-oil, or half a glass of mineral water in the morning, have often done me good service under such conditions, after the preparations of opium had failed. In Paris, in 1849, I treated every prodromic diarrhœa with laxatives, a course later pursued also by Jules Guérin, but after a comparative trial

of the different methods I have gone back to the principles mentioned, and have only seen exceptional cases where mild laxatives were occasionally useful.

When nausea, or a desire of vomiting, with a bitter taste, exists from the beginning of the diarrhœa or in the absence of diarrhœa, they are met in the lighter cases with effervescent powders, drinks containing carbonic acid gas, the ingestion of small pieces of ice, and when these remedies fail and a more obstinate disturbance of digestion exists, without previous disease of the stomach, or if the stomach derangement be due to indigestion, there should be no hesitation in administering an emetic of from fifteen to twenty grains of ipecac, in two or three divided doses, administered at short intervals of fifteen or twenty minutes. This acute dyspeptic diarrhœa is often best allayed in this way. The treatment of cholerine and of the lighter attacks of vomiting and diarrhœa, during the prevalence of cholera, is the same as for the graver forms of the disease.

Treatment of well-marked Cholera.

Having found that many of the remedies recommended were perfectly useless during the attack,—a result naturally to be expected, as the mucous membrane of the digestive tract scarcely absorbs anything at this period, and the agents which act upon it directly can hardly develop their action in the presence of so large a quantity of rice-water fluid—I have adopted for years a very simple symptomatic treatment both of the attack and its consequences. It is certain that active interference is more injurious than a simple mode of treatment, and this is almost even more true of the later period of reaction than of the attack itself.

Composure of mind is essential above all things. The word cholera should not be used in the presence of the patient, and the attack may be spoken of as cholera morbus. If the prodromic diarrhœa has resisted our efforts to check it, or if it have not existed at all, and the violent discharges have already set in, neither opium nor nitrate of silver, nor any other internal remedy will be of any avail. The most comfort will be secured

to patients by ice and by ice-cold carbonic-acid water. A piece of ice, from the size of a pea to that of a bean or hazel-nut, may be swallowed every three or five minutes, and in the intervals occasional mouthfuls of very cold seltzer or soda water. My experience has taught me to give by far the greatest preference to these agents over fermented carbonic-acid drinks like white beer, champagne, etc. If no carbonic-acid water of good quality is at hand, administer effervescent powders made of four parts of the bicarbonate of soda and three parts of tartaric acid, in a few teaspoonfuls of water, from time to time. One of the most refreshing and agreeable effervescent drinks, to many patients, is made by adding to a solution of bicarbonate of soda one or two teaspoonfuls of freshly expressed lemon-juice. Of course these mixtures are to be taken at the moment of effervescence. The burning thirst, the constant nausea, and frequent vomiting are often allayed and arrested by these means, so that patients who have once commenced with them continually call for them afterwards.

Since internal medicines, according to all experience hitherto, have proved useless during the attack, and since clysters usually do not remain, numerous experiments have been made with subcutaneous injections. The use of quinine in this way has been highly lauded, but proof of its efficacy is still lacking. On the other hand, subcutaneous injections of from a sixth to a quarter of a grain of muriate of morphia, although useless against the attack, allay the tormenting pains and cramps of the second half of the attack; at the same time these may be combated by frictions with pure chloroform or active counter-irritants to the skin. When the discharges from the bowels begin to be less frequent and copious, the attempt may be made to check the exhausting escape of watery elements from the blood by enemas containing from fifteen to twenty drops of laudanum and from eight to ten drops of a solution of chloride of iron [1] or three or four grains of nitrate of silver. Decomposition of the silver salt by the chlorides of the cholera fluids in the rectum, when the discharges are diminishing, is less to be feared than

[1] The stronger solution of the Br. Ph.

the useless administration of this remedy by the mouth in the first phase of the attack. In cases in which diarrhœa is still present at the end of the attack, from five to eight drops of the tincture of opium may be repeatedly taken in linden-blossom tea. During the attack care must be taken to secure pure air in the room, frequent removal of the excreta, the greatest possible cleanliness, and rest; especially should all persons not directly attendant on the patient be kept at a distance, and those who are present are urgently entreated to preserve perfect composure and presence of mind, and to abstain from all demonstrations of grief. Præcordial anxiety is best overcome in the beginning by compresses over the abdomen, later by sinapisms with mustard-paper, mustard, spirits, etc.

The injection of water or defibrinated blood into the veins after the attack has generally proven fatal, and should not be advised. We have no right to lessen the patient's chances by unwarranted interference; on the contrary, it is our duty to oppose any such experiments.

The abuse of stimulants and irritants in that particular phase where the patient has survived the attack and the temperature begins to fall, and the pulse to fail, has been as great as that of the so-called specific and abortive treatment in the beginning. The discreet and experienced practitioner will here also refrain from too energetic interference. We may favor the reaction by proper and timely treatment, but it is not in our power to force it when the strength of the organism is totally inefficient.

Should the temperature begin to fall, friction of the extremities may be resorted to; this may be done with flannel, perhaps also with opodeldoc, or liniment of camphor, to which a fifth part of the water of ammonia has been added; the limbs should then be enveloped in flannel or warm cloths; hydropathic envelopes also warm up the surface in cases which are not too severe. If this method be not adopted, warm (not hot) jugs may be put to the hands and feet, and light, frequently warmed aromatic drinks, chamomile tea, peppermint tea, etc., may be given internally in small doses at a time. Linden-blossom tea has proved in my experience to be the most agreeable drink to most patients. A mild irritant may be added to some such tea. I

prefer the anisated spirit of ammonia[1] to other ammoniacal preparations—especially to the water of ammonia—and like to add from ten to fifteen drops of the anisated ammonia to every cup of tea, up to the period of thorough restoration of temperature. I have rarely seen good effects from the stronger irritants, as oil of peppermint, in doses of from two to three drops, or three or four grains of trichloride of carbon. In very grave and rapidly sinking cases, a teaspoonful or more of old fiery wine—Burgundy, Hungarian, especially Tokay or old Rhine wine—should be given every half hour or hour, alone or with twenty-five or thirty drops of the ammoniated tincture of musk. The use of these stronger irritants, although certainly rational, is seldom followed by good results, but they should be tried, nevertheless, because of their occasional efficacy in some very grave cases. The fundamental principle of treatment for the majority of cases is and remains moderate heat and the cautious use of irritants.

Should patients complain of a sense of fulness, weight, and pains in the head during the period of reaction, the best treatment consists in the application of cold compresses to the head and frequent sinapisms to the lower extremities. Should nausea, vomiting, and diarrhœa recur anew after the algid stage, as is not infrequently the case, though always with much less intensity, the use of ice and carbonic-acid water is again the most efficacious treatment, and if they do not suffice they may be assisted by small doses of opium, best in saturated solutions, and by enemas of nitrate of silver and laudanum.

The greatest caution must always be exercised as regards the nutrition of patients. If the temperature continues to rise, a small, later a large, spoonful of good beef soup may be given every three to four hours. When the reaction has become established, tea or coffee, with equal parts of milk, may be given several times a day; but the greatest care must be taken to proceed gradually and with the closest supervision to an increased and more solid diet. This should be animal food, simply prepared, and it should not be allowed at all until

[1] Oil of anise, one part; alcohol, twenty-four parts; dissolve and add five parts of water of ammonia.—*German Ph.*

the tongue has cleaned off and all intestinal catarrh has ceased. Indigestion is as fatal in the convalescence of cholera as in typhoid fever.

When the typhoid stage has set in we have no means of rendering normal the excretion of urine and urea. The chief effort here, too, as in cases of grave and protracted convalescence, must be devoted to the regulation of the digestive organs, as every attempt to favor the increasing strength without their proper action is an idle endeavor. The anti-emetic method of treatment by ice and carbonic-acid water is often necessary, even in the second half of the first and the beginning of the second week. The bitters may then be used with advantage, especially in combination with rhubarb; infusion of quassia, centaury, or buck-bean, compound tincture of gentian, tincture of orange-peel, etc. A very excellent preparation is a combination of equal parts of tincture of rhubarb and tincture of orange-peel in twenty to thirty drop doses in sweetened water, three or four times a day. Should constipation ensue, or alternate with light diarrhœa, a teaspoonful of an infusion of rhubarb (from fifteen to thirty grains of rhubarb to four ounces of water, and one ounce of syrup of orange-peel) may be given every two hours. In cases of still more obstinate constipation pills of rhubarb and aloes may be ordered in mild, laxative doses. For the abdominal pains with meteorism, which occur from time to time, occasional enemas of ether (two drachms to four ounces of water) are very useful. Warm aromatic herb-baths have been quite successful in my hands in adding to the comfort of patients during convalescence. An increasingly liberal diet may only be commenced when the digestive organs have become perfectly normal, and must then only be continued under constant observation.

The treatment of bronchitic, pneumonic, and pleuritic complications, when they occur secondarily, is that which is customary for these conditions. This is true also of secondary diphtheritis of the pharynx, dysentery, endometritis, etc.

The best treatment of cholera, therefore, in the state of existing knowledge, is a carefully regulated hygienic and a correctly interpreted symptomatic treatment, with avoidance of all perturbatory methods in the least degree inutile if not even injurious.

THE PLAGUE.

LIEBERMEISTER.

THE PLAGUE.

J. F. C. Hecker, Die grossen Volkskrankheiten des Mittelalters. Herausgegeben von *A. Hirsch*. Berlin, 1865.—*H. Haeser*, Historisch-pathologische Untersuchungen. Dresden u. Leipzig, 1839.—*Derselbe*, Lehrbuch der Geschichte der Medicin und der epidemischen Krankheiten. Bd. II. 2. Aufl. Jena, 1865.—*A. Hirsch*, Historisch-pathologische Untersuchungen über die typhösen Krankheiten etc. Prager Vierteljahrschrift. Bd. XXXII., 1851.—*Derselbe*, Handbuch der historisch-geographischen Pathologie. Bd. I. Abthlg. 1. Erlangen, 1859. S. 192 ff.—*Griesinger*, Infectionskrankheiten. In Virchow's Handbuch der spec. Pathol. u. Ther. 2. Aufl. Erlangen, 1864. S. 292 ff.

The name Pest (Pestis, Pestilentia, *Λοιμός*) was given during antiquity and the middle ages to every epidemic disease, in which the mortality was very large. Gradually, however, the term came to be used almost altogether to designate a certain disease, distinguished above all others by its epidemical appearance and by its heavy mortality. At present the term Pest, or Plague, is understood exclusively to mean the bubo plague.

According to the testimony of Rufus of Ephesus, as given by Oribasius, the bubo plague occurred in Egypt, Libya, and Syria, already before the beginning of the present era. The first extensive epidemic of the bubo plague in Europe occurred in the middle of the sixth century, and is known under the name of the *Plague of Justinian*. Since then plague epidemics have very often occurred on European soil, and during the middle ages and the first years of modern times, it was the worst of the epidemic diseases that visited the people of Europe. Since the middle of the seventeenth century the plague epidemics have begun, gradually, to be less frequent in Europe, and the western European continent has not been visited by the disease since the serious

epidemic which occurred in Provence in the years 1720 and 1721. In the present century plague epidemics have occurred principally in south-eastern Europe, and particularly in the countries bordering on the lower Danube and the Black Sea, and also in the Balkan peninsula, all these places having been repeatedly visited during the second and third decades. In the more western European countries epidemics have occurred in only three places, viz., in Malta (1813), in Noja, in lower Italy (1815), and in Majorca (1820). Since 1841 Europe has remained free from the plague, and since 1843 it has not even occurred in Asiatic Turkey, nor in Egypt since 1844.

It seemed for a long time as if the plague had entirely disappeared from the earth; during the last decades, however, unmistakable epidemics of the disease, though of comparatively limited extent, have appeared in isolated regions of Africa and Asia. In 1858 and 1859 an epidemic of bubo plague occurred among the Arabs in the vicinity of Benghasi, in North Africa, another in 1857 in Mesopotamia, and one in 1871 in Persian Kurdistan.

Apart from the fact that the disease has not yet died out, its historical and theoretical interest would make it seem unwarranted if the affection were not mentioned in a hand-book of pathology.

I have attempted, in the following description, to present the most important theoretical and practical points; but, as regards the rest, to express myself in as few words as possible. My description is based mostly on the above-mentioned works of Hecker, Haeser, Hirsch, and Griesinger. At the same time I have not omitted to make use, in as extended a manner as possible, of the reports of writers who were eye-witnesses; for in this way alone is it possible to obtain a distinct conception of the nature and effects of this pestilence.

ETIOLOGY.

It is universally acknowledged in modern times that the plague never originated autochthonously in Europe, but that it was always introduced. Formerly, Egypt and Syria were looked upon as the real fatherland of the pestilence; but this idea can no

longer be entertained, inasmuch as these countries have been free from the disease for the past thirty years. Even the well-known epidemics of the last decades, which occurred in Africa and Asia, give no proof of having originated there, because epidemics of the same disease had already previously occurred in these very regions. Furthermore, with regard to the epidemic of 1867 in Mesopotamia, there are reports that a malignant fever, confined to a limited extent of country, has been observed in 1856, 1858, 1859–60, 1861–64, and 1865. So far, then, as our researches have gone, there is no good reason for attributing an autochthonous origin to the plague. Those who maintain such a view will find themselves obliged to refer the origin of the disease to the dark ages, and to the remote regions of unknown lands. The true history of the disease has shown that it is propagated in a continuous manner, and that its spread takes place only by transportation.

According to the received opinion, the plague can be communicated from one person to another, and it is looked upon, to a certain degree, as the prototype of a contagious disease. The doctrine of the contagiousness of the plague is often assailed, and already the statement is often made that the disease is not communicable through sick people, but arises solely from impurities in the atmosphere or other telluric or cosmical influences. Such statements are often based only upon false reasoning, and need really no other proof of their falsity than a citation of the positive facts. But the doubts regarding the contagiousness of the disease have been often reiterated by physicians who had themselves passed through serious plague epidemics and seen numerous patients. For example, the physicians sent from Montpellier to Marseilles, during the plague of 1720, declared it to be a popular prejudice that the community could become infected by those already sick with the disease, and later, the same assertion was made by very many physicians who were personally familiar with the manner in which the plague is disseminated.

In a discussion based on facts as to whether a disease is contagious or not, we can safely assume that it belongs to the contagious-miasmatic diseases in the sense already defined in the introduction. I would call attention to the fact that the same

discussion has been and is still going on in relation to the contagiousness of typhoid fever, cholera, and dysentery, which all, undoubtedly, belong to the contagious-miasmatic diseases ; but no intelligent observer has yet doubted the contagiousness of typhus fever, small-pox, and other purely contagious diseases. Besides, in many of the reports, we find facts mentioned which favor the opinion that the plague is not communicated directly from individual to individual, but generally in a round-about way. Indeed these facts were the more positive in character, the less prejudiced were the observers who reported them, and the less the experience they had had of other diseases which might have influenced their views in regard to this particular disease. If we had never had variola and other acute eruptive diseases, or typhus fever or scabies, the facts observed in reference to the plague would never have led any observer to the conclusion that the disease could be transmitted directly.

The reports of the first extensive plague epidemic, which extended over almost all the known world—the plague of Justinian—are worth mentioning in this connection. The communications of the different observers,[1] who were not themselves physicians, and who were, so to speak, far removed from all theories about the causes of the plague and its manner of dissemination, show plainly that a direct transmission of the disease from person to person was at least not the rule. Procopius, for instance, relates "that no physician nor layman, not even the servants of the patients, or those who buried them, caught the disease through contact with the sick ; while many others, without any apparent reason, were fatally attacked." Euagrius also states that many who lived with the patients and came in close contact with many of the sick and dead were not attacked ; he reports, however, that the disease could be brought from plague localities by individuals who themselves escaped the malady entirely. Finally, there are statements in these reports which could be interpreted as referring to the formation of centres of infection, and to house epidemics.

Haeser, in speaking of these reports, says :—

[1] Printed in *Haeser's* Geschichte der Medicin. Bd. II. Anhang S. 12 ff.

"Procopius and Euagrius report that immediate contact with the sick does not communicate the disease; that physicians and attendants, notwithstanding all the care they bestowed on the sufferers, were not attacked more often than others, and perhaps seldomer, while many who had kept aloof succumbed to the disease. Such testimony is important, because it dates from a time when the question of contagiousness was not affected by preconceived opinion; it is important, too, because the observers were perfectly free from prejudice, and had not the least occasion for making concessions to any of the theories of the physicians or of the government. Procopius and Euagrius are anti-contagionists, without either knowing it or wishing to be such."

In later reports we often find statements founded on fact which pretty clearly indicate that the plague is disseminated almost exclusively in an indirect manner. Thus, it is stated that the observers very often expressed their astonishment that physicians and ecclesiastics, who came in close contact with the plague patients and with the dead, did not contract the disease. The priests saw in this the proof of a special divine protection in such a work of charity; while the physicians inferred that fear was the principal cause of the disease, and, consequently, those who had no fear whatever would not be attacked. The Turks, after gaining an acquaintance with the medical doctrines taught in Europe, seem to have gradually adopted the idea of the contagiousness of the plague.

Negative testimony, however great, would always be very considerably outweighed by positive testimony; in fact, the latter shows incontrovertibly that the plague is propagated only by a continuous transmission. That it is transmitted directly from person to person is very doubtful; for, if we consider the statements upon which this belief is based, we shall find that they have apparently been made under the influence of a previously adopted theory. The writers were from the beginning so perfectly convinced of the contagiousness of the plague that they declared that not only was it dangerous to remain near a sick person, but even to look at him would be likely to result in infection, and they endeavored to decide at how great a distance the contagion would act. Repeated and successful inoculations would have to be regarded as proof of the purely contagious nature of the disease, if at the same time all the attending

circumstances were of a nature not to complicate the result. But at the present day severe local manifestations, produced by inoculation or the accidental transmission of the pus from buboes or carbuncles, would scarcely be looked upon as proof of the contagiousness of the disease. It would be just as little conclusive if any one, after having been inoculated, should actually take the plague under circumstances which might have been favorable to his taking it, even without the aid of inoculation; and the conclusion would be still further invalidated if, at the same time, the majority of similar experiments yielded negative results.[1]

The question, therefore, as to the manner in which the plague is disseminated, cannot yet be decided with certainty. An unprejudiced examination of the foregoing testimony seems to give a strong probability to the opinion that the plague belongs to the contagious-miasmatic class, in the sense given to this term in the introduction, and that it is not a purely contagious disease. But even if it were possible to prove an actual transmission from individual to individual, the facts would, nevertheless, necessitate the conclusion that the contagion takes place far more rarely by the direct method of transmission than by the indirect, *e.g.*, through clothes and other effects.

The discovery that the contagion could very often be carried by articles of various kinds, resulted in a division of the same into two classes, those which were susceptible and those which were not susceptible of infection. Wool, cotton, silk, horsehair, flax, hemp, and everything manufactured from them, together with skins, feathers, sponges, paper, books, rags, animals with wool, hair, or feathers, et cetera—all these were declared susceptible in various degrees. While, on the other hand, all kinds of grain (if not mixed with susceptible substances), bread, metal, gold (if not dirty or rusty), etc., were declared not susceptible.

Lately, the idea of contagion through the medium of articles of merchandise has been often contradicted, although the facts stated in the earlier reports seem to favor the view in a very

[1] Compare *F. A. Bulard*, Ueber die orientalische Pest. Uebersetzt von H. Müller. Leipzig, 1840.

positive manner, and at present it is generally conceded that the transmission can only occur through the bedding, clothes, and such-like effects which have been used by the patients.

The *stage of incubation* is given by observers at from two to seven days; it is only in rare cases that it seems to last longer than seven days. On the other hand, it would seem that the plague poison is capable of living a very long time, under certain conditions, outside of the human body, as we may infer from the occurrence of individual cases years after the expiration of an epidemic (sporadic plague), and from the breaking out again of an epidemic after a very long interval and without any new importation of the disease.

While the real cause of a plague epidemic always consists in the importation of a specific poison, we have at the same time a certain number of "*auxiliary causes*," upon which depends the development of the disease in a given place and at certain times. The dissemination of the poison and the outbreak of an epidemic are favored by bad social conditions of every kind, but particularly by deficient ventilation of the streets and houses, by the crowding together of many individuals into a small space, and by uncleanliness. The accumulation of unburied or imperfectly buried human corpses has been looked upon for ages as the real cause of the plague, and this opinion has led to the extravagant opinion entertained by Pariset (an opinion nevertheless very easily refuted), that the introduction of the Christian religion into Egypt, in connection with the custom of simple burial instead of embalming, has been the means of originating the plague. It was generally assumed, and probably not without good reason, that the dead bodies of those who had died of the plague could disseminate the disease, even though a long time had elapsed since death, so that reopening the graves could cause a fresh outbreak of the malady. Such graveyards were therefore frequently surrounded with walls, upon which notices were posted to the effect that the reopening of a grave would be punished as a capital offence.

The *season of the year* and *the climate* have only a very slight influence, and yet moderate warmth in connection with dampness seems to be quite favorable to the propagation of

the disease. Most of the epidemics in European Turkey have occurred in the spring and in the beginning of summer. On the other hand, severely cold weather or very dry heat does not seem to hinder the spreading of the disease, although they exercise a considerable influence in diminishing it. In Cairo the epidemics generally ceased on the commencement of intense summer heat; in Nubia, and particularly in countries with a tropical climate, the plague has not yet made its appearance. Dampness, and particularly a thoroughly wet soil, are favorable to the dissemination of the disease, and many elevated and dry regions have enjoyed complete immunity from it.

The attempt has often been made to associate the occurrence of the plague with any extraordinary event in nature. So, for example, in former times it was customary to associate it with unusual constellations of the planets or with comets, and in later times with earthquakes, land-slides, and so on; and even this accidental coincidence of such events with plague epidemics has been made the subject of very careful and extended investigations. We cannot, of course, at the present day, attribute any influence to such things, except perhaps that a widely extended earthquake may favor such an occurrence by contributing to the increase of social misery. On the other hand, military expeditions, with their attendant results, floods, failure of crops, famine, etc., can, under certain conditions, become very important elements in the dissemination of the disease.

The *individual disposition* to fall ill seems to be increased by all weakening influences, as for example excessive bodily or mental exertion, previous diseases, etc. Under the head of occasional causes, belong perhaps catching cold, errors in diet, mental emotion, and perhaps in a particular degree the fear of the prevailing disease. Those who have had the disease once and recovered from it possess a relative immunity; should a second attack occur, it is generally less intense. Water-carriers and attendants at the baths, still more, however, oil-carriers and dealers in oil and fat, are said to be very rarely attacked. Sex and time of life seem to have no particular influence on the disposition to take the disease, except that persons over fifty years of age rarely take the disease.

SYMPTOMATOLOGY.

The plague, in well-formed *typical cases*, is a fever of the most acute and aggravated kind, accompanied with localizations in the form of buboes or carbuncles. Four stages are recognizable:—1. The stage of invasion; 2. The stage of intense fever; 3. The stage of fully developed localizations; and 4. The stage of convalescence.

The *stage of invasion* begins generally quite suddenly, and, according to the descriptions, fever is generally if not always absent. The manifestations during this stage are therefore probably the direct effects of the infection, and are, perhaps, analogous to the prodromic manifestations in the first stage of typhoid fever, only much more intense than these.

The characteristic symptoms consist in a complete disturbance of the general state of health, and in more than ordinary bodily and mental weakness. There is, besides, headache, a sense of fulness in the head, and dizziness; the face is pale and flabby, the features distorted, the eyes languid, the speech awkward, the gait staggering, in a word, most authors compare the condition of the patient with that of an intoxicated man. Nausea, vomiting, and also diarrhœa sometimes occur. This stage is often only imperfectly developed, and lasts only a few hours, while in other cases it may last one or more days. The change from this to the second stage is marked by the occurrence of fever, which is often introduced by a slight feeling of chilliness or by a well-marked chill.

The *second stage* is characterized by the continuance of the extreme lassitude, but more particularly by the existence of an intense fever, with its attendant consequences. The skin is hot and dry; the patient complains of inward heat and unquenchable thirst; the eyes are injected, the tongue moist, broad, white, and covered with a pearl-colored or chalk-like coating; the vomiting often continues. The pulse is very frequent, as high sometimes as 120, and the respiration is accelerated. Soon the patient passes into a well-formed typhous condition, characterized sometimes by active, wild delirium, but often by a mild form, which

finally passes into sopor and coma. The tongue becomes dry, cracked, hard; the tongue, teeth, lips, and nostrils are covered with a darkish mucus or with soot-colored crusts. Then come the signs of cardiac weakness or paralysis; the pulse grows feeble, small, often irregular, and sometimes scarcely to be felt; coldness of the peripherical parts sets in, and sometimes there is cyanosis of the lips. After the fever has continued for two or three days the buboes begin to make their appearance, preceded oftentimes by tenderness upon pressure in the corresponding parts.

In the *third stage*, when the *local manifestations* occur, the fever as a rule diminishes, while occasionally at the same time the surface of the body breaks out into a perspiration, sticky in character and having a strong odor; the pulse also grows fuller, and falls to 100 or even 90 beats; and the mind becomes clearer. The swelling of the lymphatic glands, in which consists the characteristic local manifestation, occurs oftenest in the inguinal region, though it may also occur in the axillæ or on the neck; as a rule it does not affect more than one of these regions. In the inguinal region they are usually found lower down on the thigh than the ordinary venereal buboes. Sometimes they are so small that they can be found only after careful search; in other cases they attain the size of a hen's egg, or are even larger. When they suppurate, which they often do, the case is considered more favorable: the pus is often of an ichorous nature, and destruction of the neighboring soft parts takes place. In other cases the tumors become resolved.

The carbuncles are of less constant occurrence than the buboes, and are usually found on the lower extremities, on the buttocks, and on the back of the neck. In favorable cases the gangrene ceases to make any further encroachment after a few days, and the slough separates by the process of suppuration. In the severest cases, petechiæ, vibices, or extensive ecchymoses sometimes appear just before death.

Convalescence begins generally between the sixth and the tenth days, and is often protracted by continuous suppuration of the buboes. Among the sequelæ should be enumerated parotitis, furuncle, abscesses of the skin and muscles, pneumonia,

protracted fever with continued typhous condition, dropsy, partial paralysis, mental disturbances, etc. Genuine relapses may also take place.

Besides the well-formed severe cases there are also less severe cases, which present all the essential symptoms, but in greatly diminished intensity; such cases occur especially towards the end of an epidemic, when the disease shows a less malignant character. There are also cases which could be called abortive; in these a profuse sweating, just after the appearance of the local symptoms, ushers in a rapid diminution of the fever, and all the manifestations of the disease subside. We may also meet with quite mild cases, with only slight fever and without any appreciable local trouble,—cases which simply consist in a disturbance of the general health, accompanied by slight fever, and running its course sometimes rather slowly. Finally, cases have been described in which buboes and carbuncles occur, while at the same time the general malaise and the fever are only slight, or do not show themselves until later, or may even be absent altogether. Many other variations from the usual course are described, but it should not be forgotten that during the different plague epidemics the observers were disposed to reckon all other diseases as coming under the head of the plague. This circumstance accounts for the disposition to describe the plague as, *par excellence*, a disease of many forms.

DIFFERENT WAYS OF TERMINATION.

Death can occur during any stage of the disease. Cases are described in which death took place during the stage of invasion, before the distinct symptoms of fever had shown themselves; and others are recorded in which death occurred in the stage of fever, before the development of the local manifestations. The term "pestis siderans" is applied to those cases which run their course very rapidly. Death most generally takes place between the third and the fifth days; after the seventh day the danger of the disease is past, and only the sequelæ may yet prove dangerous.

The mortality of the plague is greater than that of any other

epidemic disease. Except in the case of a very few relatively mild epidemics, a very large majority of those attacked die. At the very beginning of an epidemic it is common for almost all the sick to die, and those who have given us reports of these epidemics regard it as a marked evidence of improvement when at least a few patients escape. The mortality often for quite a length of time amounts to from seventy to ninety per cent., and it is rarely less than sixty per cent.

The danger of contracting the disease is exceedingly great in many of these epidemics, especially where the hygienic conditions are unfavorable and the measures for the seclusion of the patients are imperfectly carried out. In this way it happens sometimes—which is never true of any other epidemic disease—that more than half of the population of a place dies.

The city of Toulon,[1] for example, had in August, 1720, according to an accurate census, 26,276 inhabitants. In 1721 the city was attacked by the plague, and the number of deaths—so far as the lists indicated—amounted to 13,283, or more than one-half of the entire population. In reality, however, the number was greater. After the close of the epidemic a new census was taken, which returned only 10,493 inhabitants. The chief burgomaster of the city, who is the authority for this statement, and who was the only one of the municipal officers who survived the epidemic, does not deny that emigration may have contributed to the decrease in the population, but calculates that, including the strangers, more than 16,000 died. Of the survivors there were not more than 6,000 who had not had the disease. There were, accordingly, out of a population of 26,000 human beings, about 20,000 who had been taken sick, and of these 16,000 had died. For the whole of Provence, in which at that time more than sixty large and small places—the names of which are all stated—were visited by the plague, the number of the dead is estimated at 200,000; no accurate estimate has been made of the mortality in the other towns.

Nevertheless it seems to have been a rare occurrence, even in the worst plague seasons, for more than half of the population of a large town to die of the disease, while the complete extinction of individual houses and neighborhoods occurred very often.

[1] *D'Antrechaux*, Merkwürdige Nachrichten von der Pest in Toulon. Uebersetzt von Knigge. Nebst einer Vorrede von *J. A. H. Reimarus*. Hamburg, 1794.—Reimarus's preface well merits perusal. It is, in fact, a special treatise "On the General Characteristics of Infectious Epidemics," in which the author—writing at the end of the last century—expresses in the main the same views as those which I have endeavored to set forth in the introduction to the infectious diseases. Reimarus's work, however, was not brought to my notice until after this introduction had been written.

ANATOMICAL CHANGES.

The gross morbid appearances found in the bodies of those who have died of the plague are comparatively slight. The only constant changes found are the enlarged lymphatic glands. These glandular swellings are often found only on the inside of the body, out of sight. Thus, for example, besides the buboes in the inguinal region, there are also glandular swellings in the pelvis, and further upwards near the diaphragm; and where the buboes occupy the regions of the neck or axilla, the mediastinal and bronchial glands will be found enlarged. Where, however, there is any considerable enlargement of the glands, it is usually confined to a single region. Extravasations of blood are often found in the neighborhood of the affected glands. According to Griesinger, the glandular parenchyma, in the larger swellings, is at one time uniformly red, like the lees of wine, or violet; at another time, whitish or grained, and of a pulpy, brain-like consistence, or denser and more like fat. Sometimes the tissue is completely soft like jelly, but it is rare to find small collections of pus in it. The mesenteric glands are generally somewhat hypertrophied, injected, or ecchymotic. The spleen is almost always hypertrophied, soft, and of dark color. Ecchymoses are often found in the mucous membranes and serous membranes, in the parenchyma of the different organs, and in the connective tissue. Finally, the reports of many post-mortem examinations point towards the probable presence of extensive parenchymatous degeneration in the different organs.

TREATMENT.

The treatment of the plague consists principally in *prophylaxis*. The history of this disease is very instructive in this particular, because it shows how suitable measures, when energetically carried out, can succeed in so perfectly conquering the severest of the epidemic diseases, that it no longer occurs except in half-civilized countries. This extraordinary result has been accomplished by quarantine measures rigidly carried out. A.

Hirsch, who has a most thorough knowledge of the history of popular diseases, says that "the extinction of the plague was a gradual process, and kept pace in great measure with the development and perfection of the quarantine system, as carried out not only with reference to the East, but also between neighboring countries of Europe. Indeed I cannot understand how any one, pretending to criticise facts in an unprejudiced manner, and with some regard to the condition of the plague in the East, can for a moment hesitate to attribute the chief cause of the disappearance of the plague from European soil to the development of a well-regulated quarantine system."

The isolation system has often shown itself effectual for individual places and houses, and there is no doubt but that this, wherever it has been systematically carried out, has hindered the intrusion of the plague. The last epidemics in Egypt have furnished repeated examples of towns or villages, which, although surrounded as it were on all sides by the plague, have nevertheless entirely escaped it, through the strict carrying out of the isolation plan.[1]

It is difficult at the present day to realize with what pitiless severity in early ages the plan of isolation was carried out. Almost everywhere the infringement of the commands issued during a plague was threatened with death, and we find in the reports frequent examples of the fact that this threat was carried out in the most expeditious manner. The isolation was often so absolute that all direct as well as indirect intercourse was cut off.

When cases of the plague occurred in the little town of Noja in lower Italy, in 1815, troops were despatched immediately to surround the place with a cordon. The city was encircled by two deep ditches, and, opposite the gates, these ditches were spanned by two drawbridges, which served as a means for the introduction of provisions into the town, but no other communication was allowed. Only letters were allowed to leave the city, and these had first to be dipped in vinegar. Cannons were posted at the city gates. The ditches were occupied by sentinels, who were ordered to shoot down any one who approached and did not stand still the moment he was hailed. A plague patient, who escaped while delirious and attempted to pass the lines, was actually shot dead. Besides this strict cordon, two others were established outside of the first. Those who disobeyed the orders were treated with

[1] Compare *Bulard*, l. c. S. 23 ff.;—also *Griesinger*, l. c. 2 Aufl. S. 299.

the greatest severity. An inhabitant of Noja who had thrown a pack of cards to the soldiers, together with the soldier who picked it up, were tried by court-martial and shot. In that quarter of the town where the plague first appeared and was the fiercest, 192 houses were burned or torn down.—(*J. J. A. Schönberg*, Ueber die Pest zu Noja. Nürnberg, 1818.—*V. Morea*, Storia della peste di Noja. Napoli, 1817.)

Such measures can only be understood, by remembering that the devastation produced by the plague was fresh in the memory of the people. Lower Italy and Europe probably owed their protection from the plague to the severity practised in this particular instance. If we were to employ at the present time only one-half of the energy expended in former times upon the prevention of the plague, many a disease, which now commonly takes on the character of an epidemic, would be expelled from European soil. Such strenuous measures are now possible only when the calamity has overstepped every endurable limit.

The second point of interest in the annihilation of the plague is *the improvement of the sanitary condition* of Europe as well as of that part of the Orient which was formerly the chief source of the disease. Egypt has ceased to be a breeding-place of the plague since the sanitary conditions of that country have improved, and particularly since the system of burial has undergone a complete change,—all of which are the legitimate results of the rigorous reforms instituted by Mohammed Ali.

The experience of the past, however, will not be lost; and if we should ever again be threatened with an outbreak of the plague in Europe, we shall know exactly what measures to adopt to ward off the danger. It is unnecessary to enter into the history of the quarantine system, or criticise the existing arrangements.[1] It is also scarcely necessary to mention that owing to our imperfect knowledge of the nature of the plague and its mode of development, as well as of the manner in which the contagion is communicated, etc., it would be advisable to do rather too much than too little; and where there is any doubt, it is better to follow the sure way. At all events, quarantine measures, so far as the plague is concerned, would be quite superfluous in Europe at the present time; they would have to be re-established only in case the plague should appear in those regions with which we stand in direct communication.

[1] Consult the exhaustive article on this subject by Colin, in the Dictionnaire Encyclopédique des Sciences Méd., 3 Série, T. 1. 1873. Article "Quarantaines."

If the plague has not yet died out, and if there is still danger that it may once more attain a wide dissemination, still we may perhaps indulge the hope that its rôle as a widespread epidemic is ended. The experience of this century seems in fact to show that, where the necessary energy is employed, it is not so very difficult to confine the disease within narrow limits, and finally to utterly dislodge it.[1] The liability to contract the disease and the mortality are both very great only when the hygienic conditions are decidedly bad—as was the case during the middle ages, and still is the case to-day in certain parts of the East,—or when the patients are left not only without any treatment, but even without ordinary care and watching. Instances are on record where, under similar circumstances, other diseases, such as dysentery and typhus fever, have made their appearance under such a fatal form and among so many individuals as to remind us of the severest epidemics of the plague.[2] Civilized lands will probably never again be in danger of a devastating epidemic of the plague, provided they do not give themselves up to reckless carelessness.

No efficient protection is known for those who cannot entirely isolate themselves. Some observers (Diemerbroek and others) believe that they have been protected by smoking tobacco ;—they were in the habit of placing a leaf of tobacco on the wrist of the patient when they wished to feel the pulse, or on any part of the body which they had occasion to touch. Setons or other derivatives were very often used. Rubbing the body, and particularly the face and the hands, with oil was supposed to give a certain protection. Strict cleanliness, the frequent use of water, soap, etc., seem to be useful. Bed and body linen, and other effects of this sort which were considered particularly suspicious, were often burned. In the case of ordinary wares which required disinfection, it was generally customary to subject them to a thor-

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[1] Compare *Faulkner*, A Treatise on the Plague. London, 1820.—*Czetyrkin*, Die Pest in der Russischen Armee zur Zeit des Türkenkriegs im Jahre 1828 und 1829. Berlin, 1837.—*L. A. Gosse*, Relation de la peste qui a regné en Grèce en 1827 et 1828. Paris, 1838.

[2] Compare *B. G. A. Richter*, Medizinische Geschichte der Belagerung und Einnahme der Festung Torgau und Beschreibung der Epidemie, welche daselbst in den Jahren 1813 und 1814 herrschte. Berlin, 1814.

ough ventilation, particularly in the sunlight. The fumes of burning sulphur were early employed. The surest disinfection, as may be easily imagined, was obtained by the employment of a high temperature,—a practice often recommended even in those early days.

The treatment of individual cases can only be expectant and symptomatic. According to general principles, and bearing in mind the fact that death seems generally to result from paralysis of the heart, the employment of strong restoratives, especially alcohol, is to be recommended; and during the stage of high fever an energetic antipyretic treatment would seem to be indicated. For example, large doses of quinine, or even cold baths, might be used. Pouring cold water over the body seems to have been useful in many instances; on the other hand, quinine in antipyretic doses has never been employed. In early times the buboes were sometimes cut out immediately after they had begun to swell, and this plan of treatment enjoyed considerable reputation; but subsequently they were treated for the most part with poultices and then opened as soon as pus had formed.

THE BLACK DEATH.

J. F. C. Hecker, Der schwarze Tod im vierzehnten Jahrhundert. Berlin, 1832. Auch abgedruckt in Volkskrankheiten des Mittelalters, mit Zusätzen von *Hirsch*. —*Haeser*, l. c.—*A. Hirsch*, Die indische Pest und der schwarze Tod. Virchow's Archiv. Bd. V. 1853. S. 508.

About the middle of the fourteenth century almost all the known countries of this earth were devastated by a malady which was more murderous than all previous or succeeding epidemics. It was "that frightful epidemic of the plague, which was known under the name of the black death, and which fills one of the darkest pages in the history of the human race. Its name still lives in the mouths of the people, fills their minds with horror, and was the most terrible scourge which man has ever seen." —(Hirsch.)

The disease presented all the essential characteristics of the ordinary bubo plague, but in addition there was also a lung complication; in numerous cases blood was expectorated, a symptom which seldom occurred in the bubo plague, properly so called. The mortality was, if possible, greater than in the ordinary plague, and death followed more quickly, generally within three days.

The majority of authors are inclined to identify the black death with the real bubo plague, and to look upon the lung affection as an accidental complication. A. Hirsch, on the other hand, is of the opinion that we have to do here with a disease strongly resembling the bubo plague, but nevertheless quite different from it, and he thinks that he can recognize the black death of the fourteenth century in the so-called Indian plague or Pali plague, a disease which prevailed from 1815 to 1821 in the East Indian provinces of Kutch and Guzerat, from 1836 to 1838 for the first time in the city of Pali, and then extended further, prevailing in the districts of Guhrwal and Kumaon (on the spurs

of the Himalayas) as an endemic disease. In fact the opinion is everywhere the same, so far as we can judge from the reports, and it is in a high degree probable that this Indian plague, which now and then even at the present day oversteps its usual boundaries, is the same disease which extended, about the middle of the fourteenth century, over the whole known world and swept away a large portion of mankind. Besides, the reports which we possess seem to show that the great epidemic already referred to did not consist of one disease only, but that the common oriental bubo plague, and perhaps also other diseases, had their share in it.

YELLOW FEVER.

HAENISCH.

YELLOW FEVER.

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Note.—A very complete bibliography, arranged alphabetically, will be found in *Matthaei:* "Ueber das Gelbe Fieber." Tom. II. Hanover, 1827; also in *R. la Roche:* "Yellow Fever," etc. Vol. I. Philadelphia, 1855; and in *Griesinger:* "Infectionskrankheiten," pages 72 and 73.

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HISTORY AND ETIOLOGY.

We are entirely without trustworthy information regarding the first appearance of yellow fever. It is highly improbable that the communications of various authors, which inform us of the prevalence of the disease in the Antilles since the memory of man, really refer to yellow fever. The theory is much more tenable that the disease was first developed after the immigration of Europeans into the West India islands; at least it agrees better with many facts, which have been since observed, to consider yellow fever as an acclimation disease (of the tropics), to which immigrants are liable, than to assume that it originally prevailed as an endemic disease among the natives, and afterwards underwent a complete alteration of its character.

The Antilles were probably the cradle of yellow fever; at least accurate observations of the disease in question were first made here. From this point it spread abroad through the constant increase of human intercourse. At the present time it has established itself over a widely extended territory; it prevails mainly as an endemic in all the West India islands, in Venezuela, New Granada, and Mexico; also as far north as Charleston, on the east coast of the United States, and on the northern portion of the

west coast of Africa. Within these regions it is never completely extinct; sporadic cases are always occurring here, and from time to time it is common for more extended epidemics to develop themselves. But even outside of the territory named there have already been epidemic outbreaks of the disease, both in Europe and on the west and east coasts of America, north and south of the points mentioned; and, in fact, up to the present time epidemics of yellow fever have been observed between 43° N. and 33° S. latitude in the western hemisphere, and between 42° N. and 8° S. in the eastern.[1]

Many investigations have been undertaken, and there has been much and lively discussion as to the conditions which are necessary to the development of an epidemic of yellow fever, and also as to that peculiar character of the disease which determines its appearance and its spread. All these controversies narrow themselves down to two questions—Is yellow fever a miasmatic or is it a contagious disease? Both theories are maintained, and evidence, which is at least plausible, can be adduced in favor of each. The decision of these questions has not merely a theoretical and scientific, but an eminently practical interest. A great effort has, therefore, been made of late years to examine critically the very rich material at our disposal, because prophylactic measures against the disease, and all quarantine regulations, essentially depend upon the answer to this inquiry. This research has been carried on exhaustively, and so far conclusively, by Hirsch,[2] whose results have not been controverted, and with whom I also must declare myself completely in accord.

To bring about an epidemic of yellow fever anywhere, a series of conditions must be fulfilled which are deducible from a comparison of the histories of single epidemics. These conditions are allied partly to the external circumstances of human beings, partly to those which are personal.

Among the external circumstances are climate and terrestrial conditions, which must present a certain definite character.

The mean temperature of the year must reach at least 72° or

[1] *Hirsch*, Histor. geograph. Pathologie I., page 76.

[2] *Hirsch*, Ueber die Verbreitungsart von Gelbfieber, in Deutsche Vierteljahrsschrift für öffentl. Gesdhts.-Pflege. Vol. IV., part 3, pages 353–377.

77° Fahr. ; such a temperature, in fact, as is always observed in the tropics, especially in the Antilles. It is indeed maintained by Griesinger[1] that the temperature must be uniformly hot for a considerable time (80° Fahr.) ; but this is denied by West India physicians, who have very often seen a sudden fall of the temperature, within definite limits of course, immediately precede the outbreak of an epidemic. Should the temperature fall considerably during the prevalence of an epidemic, or should a ship on which the disease is raging reach colder latitudes, an abatement is at once observed ; and, on the occurrence of frost, an immediate extinction of the epidemic.

South and west winds operate to promote an epidemic, north and east winds, on the contrary, to restrain it.

Touching the terrestrial circumstances, it is particularly noticeable that the disease is chiefly developed in cities, and moreover in cities which have maritime commerce, whether they be upon the sea-coast or upon important rivers. Here it is almost invariably the so-called sailor quarter, *i.e.*, that quarter of the city lying nearest to the harbor, which is the first to be attacked in every new epidemic. In this quarter very insalubrious conditions generally prevail, and it forms the first centre for every fresh outbreak that occurs. But this is owing more to the quarter of the city than to the persons living there, as is proved by an observation made at Barcelona in 1821 ; here the well-to-do people lived near the water-side, the poorer ones in the higher streets, and the pestilence first began and was most fatal in those streets which lie nearest the harbor. Smaller settlements and villages, especially if they lie inland, far removed from maritime intercourse, and also large inland cities, only very rarely become the seat of an epidemic.

To the same extent as yellow fever can be called a disease of seaports, can it also be called a disease of level districts ; even moderately high mountains furnish an immunity against the disease, though the barometrical, thermometrical, and telluric conditions differ in hardly any essential respect from those of cities on a lower level.

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[1] *Griesinger*, Infectionskrankheiten. 2 ed. page 75.

We must agree with Hirsch that the absence of maritime commerce in mountainous regions, as it would there be impossible, furnishes the explanation of this difference, since such commerce exists in level though elevated plains, provided they are traversed by rivers which may serve as the means of carrying it on. The fact that yellow fever has repeatedly appeared at elevations of 2,500 feet, and even 4,000 feet, above the level of the sea, is in accordance with this explanation.[1]

In many cases a certain moisture of the soil and an accumulation of animal and vegetable substances passing into putrefaction, seem to have an undeniable influence on the causation of the disease. It is not on land alone that these things act injuriously. Want of cleanliness has often met with bitter retribution on shipboard. Here we have the offensive bilge water, the shavings of fresh wood, and in many cases portions of the cargo (sugar, wood, coal), which are found in the packing between the two skins of the hull, and which seem to retain the yellow fever poison for a long time in a state of activity, and to multiply it; they are not of themselves, however, capable of producing it. Still, though all the unfavorable conditions mentioned may have been developed on board in the highest degree, the yellow fever has never yet been observed on a ship which has not in some way come into communication with the land or with some other ship where the disease already prevailed. Supposing the existence of all the circumstances, which our present experience tells us are necessary for the development of yellow fever, or at least favorable to it, still the men living under them are not in an equal degree exposed to the danger of contracting the disease. Some are just as sure not to sicken as others are to be seized by the pestilence.

This different behavior is due to race, nativity, and acclimation ; neither age, sex, nor any other state of disease seems to have an essential influence.

As regards the influence of race, the history of every separate epidemic has established the fact that the negro race possesses an almost absolute immunity. Only such negroes were known to

[1] Compare Deutsche Virteljahrsschrift. Vol. IV., part 3, page 357.

contract the disease as had lived for a considerable time in the temperate zone, thereby forfeiting their immunity, and had then returned into the yellow-fever district shortly before an outbreak of the epidemic. Moreover, fatal epidemics have been observed among the blacks on the west coast of Africa, where yellow fever prevails endemically.

The whites are the most exposed to danger. Between the two stand the mixed races, and in fact those are just so much more subject to the infection, the more white blood flows in their veins, and the paler their skins are. But even the whites show a marked difference in respect to their susceptibility to infection; the farther distant their homes may be on either side of the special yellow-fever zone, so much the more susceptibility do they possess to the yellow-fever poison. This susceptibility, however, gradually diminishes the longer these whites have lived in the tropics, in the regions where yellow fever is endemic; it is almost entirely extinguished if they have passed through an epidemic, even without themselves becoming sick, and it is finally absolutely extinguished after once experiencing the disease. This immunity, however, lasts throughout life only if those who are acclimated remain constantly in the yellow-fever region. Should they return again to the dangerous region after a considerable interval of residence in higher latitudes, they again approach, in their susceptibility to the yellow-fever poison, the condition of recent immigrants; the only difference is, they again become acclimated much more quickly than the latter; and, in fact, a second attack of yellow fever under these circumstances is among the rarest exceptions.

We must certainly allow that acclimation produces in the tissues certain alterations, which render the reception of the yellow-fever germs more difficult or even impossible. In other words, the chief element of acclimation consists in this tissue change. An observation of Hegewitsch in Vera Cruz is interesting in this connection, viz., that natives as well as immigrants who have lived there long, and those persons who have once gone through the yellow fever, are no longer exposed to the sting of mosquitoes and other insects, from which new-comers suffer so much.

Yellow fever is most probably produced by a living miasm, which has hitherto entirely eluded microscopic demonstration, but the existence of which is argued from very many facts. These seeds of disease, as soon as they become in any way established in a human organism, set up in it that diseased process to which we are accustomed to give the name of "Yellow Fever." They are not, however, reproduced in this diseased organism, they do not multiply in it, nor migrate from it to other men; yellow fever is not then, in this sense, a contagious disease. But its seeds long retain their poisonous nature; they are, under certain circumstances, quite indestructible, and when placed in suitable external conditions are capable of kindling an epidemic even far away from their place of origin.

The identity of the yellow-fever miasm with the malaria miasm has been widely maintained, and in the West Indies it is still not unusual to hear the similarity of the two infectious materials insisted on. The difference in their operation is said to depend only upon the person affected. But besides various other grounds for rejecting this view, we have the fact that malaria is chiefly developed in rural, swampy regions, while yellow fever is a disease of cities.

The parts of a city in which the disease is apt to break out are especially favorable for the development of miasmata. The refuse which accumulates along the shores, and comes partly from the ships and partly from the houses, is often, through inefficient police supervision or the carelessness of the inhabitants, allowed to lie exposed for a long time. Being soaked twice a day with sea-water at the flood tide, and then at the ebb subjected to the influence of the tropical sun, such substances rapidly decompose and undoubtedly furnish a most congenial soil for the development of the very minute organisms which we accept as the sources of yellow fever. But they must, from their mode of operation, have a very special character, and differ essentially from other miasmal seeds, and, in reality, this difference is most probably due to the surroundings of a port and the tropical climate.

Now, if the seeds of the yellow-fever miasm possessed the power of multiplying in the first organism attacked, and of dis-

seminating themselves from it, we should still have to explain the fact that rural districts in the immediate neighborhood of an infected city do not necessarily suffer from an epidemic spread of the disease so soon as yellow-fever patients reach them. But, according to experience, this seldom or very rarely happens. The disease does not advance uninterruptedly from its point of origin, but spreads *per saltum;* an epidemic occurs only where the before-mentioned conditions are present. We have, moreover, a considerable number of reported cases, where persons living in the immediate neighborhood of the disease have escaped infection, in spite of the most direct and closest intercourse, and of the most pronounced predisposition, apart from that which is due to the prevalence of the disease as an epidemic.

It is commerce carried on in ships, and not the traffic of the great thoroughfares of the land, which serves for the diffusion of the disease. And here man's agency is not as a producer, but only as a carrier, as a medium of transmitting the infectious material, even without being himself sick, just as in the case of the cargo of a ship, its bilge-water, and, in fact, the ship itself. Should the yellow-fever miasm be brought in this way into a harbor where the various climatic and terrestrial conditions enumerated are in force, it can be reproduced and grow to an epidemic, supposing, of course, that persons capable of infection are present in sufficient number. In precisely the same way an epidemic may break out upon a ship not hitherto infected, through communication with an infected one. This may occur upon the high seas or in harbor, provided on board the ship conditions exist which are particularly favorable for a further spread of the disease, such as the various insalubrious circumstances already noticed, and the close crowding together of the men. From every ship, from every port which has thus, secondarily, become the seat of an epidemic, there can again be a further diffusion of the pestilence.

The history of single epidemics, furthermore, proves that the disease is connected in its epidemic appearance with certain seasons of the year, and in fact that the months of July, August, and September are those in which epidemics are most frequently observed.

La Roche, Yellow Fever, vol. II. page 269, gives a comparative statement of the relation as to time of the epidemics in North America. According to him epidemics began during July in Philadelphia 7 times, in New Orleans 14 times from 1817 to 1853, in New York 3 times, in Boston 2 times; during August in Philadelphia 3 times, in Charleston 6 times, in New York 2 times, in Providence 2 times, in New Orleans 9 times, and in Mobile 3 times.

Certain terrestrial relations, however, seem still to be of importance in this connection, since in particular regions epidemics have appeared at other seasons. Thus five were observed as occurring in St. Thomas in the years 1795–1833, all between October and February. According to the experience of West-India physicians, the hot summer months, in moist regions at the mouths of large rivers, are notably most prolific in epidemics. It may serve as an explanation of this circumstance, that shortly before this season the rivers habitually overflow, many animal and vegetable substances floating ashore, and remaining exposed on the banks after the subsidence of the rivers. Under the influence of the hot rays of the sun they rapidly undergo decomposition, and are thus specially fitted to give rise to miasmata.

On small rocky islands, and in seaboard cities similarly circumstanced, the hottest period is esteemed the healthiest; epidemics are here most frequently observed in the cool months, from October to February, provided, however, the temperature does not fall below 68° Fahr. This fact will be difficult of explanation, unless we consider that the greater commercial activity, which is mainly regulated by the harvest-time, falls between December and May. At those times there is a sufficient accumulation of matters predisposing to the development of yellow-fever miasm.

Perhaps, too, in these months the incidental causes are more prolific. As such may be specified soaking of the skin by rain and dew, all excesses *in Baccho et Venere*, and all indigestions.

Dr. Barton, in a statistical collection of the fatal cases in an epidemic extending over two years, emphasizes the fact that of the Sons of Temperance very few—twenty-nine—died in a membership of 2,427, and a general mortality of 5,653.

Also certain occupations decidedly predispose to yellow fever, while others confer a certain immunity, slight though it be. In

the first category belong cooks, bakers, sugar-makers, lock smiths, and blacksmiths, in short, all artisans that have much to do with fire. Workers in leather, tanners, soap-boilers, candle-moulders, butchers, and scavengers show less tendency to be attacked by yellow fever, from the fact that such people are obliged constantly to breathe bad, unhealthy air while at their work. [1]

COURSE OF THE DISEASE. [2]

Various forms of the disease are recognized by different authors, according to the peculiarities of its course.

Thus La Roche [3] distinguishes the inflammatory and the congestive forms, and divides these again into various subdivisions; the inflammatory form is either intense or mild or ephemeral; the congestive either adynamic or apoplectic, etc.

Alvarenga [4] distinguishes three principal forms, according to the severity of their course: one very slight, one very severe, and one occupying a place between the two.

Classifications of this kind, however, are always somewhat arbitrary, and are never to be strictly observed; besides, they are of no practical utility. Certain it is, that in the case of yellow fever, as well as in every other infectious disease, slight and severe forms occur. But these ought, as little in the one case as in the other, to lead to the assumption that we have to do with different morbid processes; they are merely different degrees of the same malady. We shall return to this subject when describing the course of the disease.

It is quite uniformly asserted by most authors that the disease does not appear to run an essentially different course, whether it prevail on this side of the ocean or the other, whether to the north or south of the equator.

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[1] *La Roche:* Yellow Fever, etc., vol. II. page 84.

[2] In the following pages I give the description of the disease, according to my own observations of it made in the West Indies, as published by me in the Deutsch. Archiv für klin. Medicin, XI. page 290 et seq. This is supplemented by the works of other authors; and then I add briefly some histories of cases noted by myself.

[3] *La Roche*, loc. cit., vol. I., page 136.

[4] *Alvarenga*, loc. cit., page 120.

The length of the period of incubation varies between twelve hours and several months (La Roche, loc. cit., vol. I. page 511). Such a protracted incubation is, however, but very seldom observed; most frequently from one to two or three days will elapse from the reception of the poison to the appearance of the first signs of the disease.

Sometimes prodromal phenomena precede this latter, consisting of general weakness, headache, pains in the limbs, and loss of appetite. Such cases occur in every epidemic; in the last at Lisbon, in 1857, very many appear to have begun in this way.[1] But it is impossible, from these prodromata, to diagnosticate the disease which is impending, unless one keeps in view the epidemic tendency, for such symptoms differ in no way from the precursors of other acute infectious diseases.

While apparently in the most perfect health, while walking, while at work, or asleep, men will be attacked with slight chills, alternating with heat, or in fact, most frequently, with a severe rigor. At the same time they feel very seriously ill; they are completely disheartened and throw themselves restlessly about on the bed; the countenance is decidedly flushed, the conjunctiva much injected, the eye has a peculiar lustre, and a staring look. Violent pains in the head, often confined to one side, as well as pains in the limbs, are seldom absent. The temperature is markedly elevated, and often reaches 102.5° Fahr. within a few hours after the beginning of the attack. The respiration is very superficial and much quickened; the pulse generally full and frequent. By the evening of the first day, or on the second day, a peculiar cadaveric smell is perceived in many patients, which is noticed as soon as the bedclothes are raised. Dr. Stone, of Woodville, in 1844, is said to have noticed this smell sometimes as much as fourteen days before the outbreak of the disease (La Roche, I., 240). This symptom involves the worst prognosis.

The tongue is thickly covered with a whitish, often yellowish coat, red on the edges, and marked with the impression of the teeth. The mucous membrane of the soft and hard palate becomes of a bright red color, soon followed by a marked œdema

[1] Compare *Alvarenga*, loc. cit., page 99.

of these parts; the processes of the gums between the teeth also become swollen, and are liable to frequent hemorrhages. The epigastrium is extremely sensitive to pressure, and painful even when it is not touched. All articles of food and drink introduced into the stomach are immediately vomited. The bowels are generally constipated; more rarely diarrhœa is present.

Percussion and auscultation of the heart and lungs indicate nothing abnormal.

The lumbar region is the seat of sharp pains. The urine is scanty, very concentrated, and often shows traces of albumen, even in the beginning of the disease. In some cases more or less complete suppression of urine exists, even from the outset.

All these symptoms are intensified during the next two or three days. The temperature is apt to reach its maximum of 105° Fahr. on the second day.

This was the highest temperature observed by me; La Roche, loc. cit., Vol. I. p. 206, gives it as from 104° to 110° Fahr.; others are said to have observed even a higher temperature.

The acme of the disease is of short duration and shows only trifling remissions, with equally insignificant exacerbations, which generally do not again reach the maximum height.

The sclerotic and the skin exhibit an icteroid coloration, sometimes even as early as the third day, frequently, however, not till later. The urine gives a distinct reaction of bile pigment; the fæces retain their bilious coloring, at least a clayey condition of them is only very exceptionally observed, and may well be regarded as an accidental appearance.

Frequent hemorrhages from the nose occur, and in rare cases from the stomach too; the latter are wholly wanting in the slighter attacks; they often occur first at a later stage. In any case in which they are present, they point to a very severe infection, and involve a bad prognosis; as a rule, patients attacked with them die.

Alvarenga, it must be admitted, has ascertained the occurrence of 40 recoveries out of 178 cases of black vomit in the Lisbon epidemic.

The *second stage* of the disease, beginning most commonly on

the fourth day, is recognized by a noticeable remission of almost all the symptoms.

The temperature falls very rapidly, so that even in twelve hours the normal may be again reached. In the majority of cases, however, especially in the severe ones, the defervescence is not complete; the temperature remains some tenths of a degree above 100° Fahr.; there occurs then no complete intermission, but only a marked remission. The tormenting pains in the head and limbs subside, and the subjective state of the patient is improved; he considers the danger past. Only the great sensitiveness of the stomach and the vomiting are apt not to disappear wholly. If albuminuria has not hitherto been present, it will almost always be observed in this stage.

This period of remission lasts from a few hours to two days, seldom longer. There are very few cases in which it is entirely absent, and in which the third stage proper follows directly upon the first. Sometimes the improvement in this stage is not merely apparent but real, and results in the patient's immediately passing into convalescence. But most frequently, to the second succeeds the *third stage*, in which, instead of the delusive improvement, we have an aggravation of all the symptoms.

The temperature rises again rapidly, though perhaps not so rapidly as at the onset of the disease, and after two days reaches once more a height of 104° Fahr., to return from it again, in case of recovery, by a very sharp curve to the normal, which it will not again leave.

The sensorium is almost always clear, but an infinite apathy takes possession of the patients, and it is a shocking spectacle to see them lying in full collapse, with sunken countenances, so totally unconcerned and indifferent to their condition. In rarer cases furious delirium is observed, which impels the patients to leave their beds, and gives them no rest.

The pulse is sometimes accelerated, sometimes retarded, usually small and thready.

The icterus now becomes very intense, so that the skin assumes a dark mahogany color. Next to this very pronounced jaundice, the repeated hemorrhages form the most characteristic symptom of this stage. They vary in the quantity of blood

effused, and may occur in very different situations; the mucous membrane of the nose and that of the whole intestinal tract are the parts chiefly affected; next to these the skin; more rarely the external auditory meatus, the organs of respiration and the genitals.

Hemorrhages into the stomach, which occasion black vomiting, have been in former times regarded as the essential feature of the whole disease, and even now, in the tropics, we often hear it called, from this symptom, "Black Vomit." The efforts to discover something characteristic in the vomited matter have been fruitless. Under the microscope only blood-corpuscles, epithelial cells, fat globules, muscular fibres, and other remnants of food, sarcina ventriculi, and various crystals have been ascertained to be present. Hassal only, in Southampton, claims to have discovered in them a hitherto unknown microscopic vegetation.[1]

A symptom almost equally serious with the black vomit is suppression of urine, which is often observed in this stage, and which reduces patients to an indescribably painful condition.

In some epidemics inflammations of the parotid, with a tendency to pass into suppuration,are observed, as well as an extensive formation of boils.

Death most commonly occurs in this stage. During the last few hours patients almost always fall into a deep stupor, out of which they do not again awake, or—in less frequent cases—in the midst of violent delirium they suddenly sink back lifeless on the bed.

Convulsive contractions of the diaphragm and twitchings of muscular fibres are often noticed just before the end. The temperature usually falls somewhat immediately before this, sometimes even as low as 100.5° Fahr.

But this third stage does not always end in death; recovery sometimes takes place, though not often. In that event, as above described, the temperature falls with a sharp curve to the normal, and remission and disappearance of all dangerous and painful symptoms take place after profuse sweats.

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[1] *Griesinger*, Infectionskrankheiten, page 89.

Convalescence is almost always very protracted; several weeks commonly elapse before patients are again in full possession of their strength. The sensitiveness of the stomach towards all articles difficult of digestion is of long continuance.

In the vast majority of pronounced cases of yellow fever but few of the symptoms detailed are wanting, though they do not always come under notice in the same intensity or order of succession.

Closely allied to the very marked cases described, there occur, in certain epidemics, perhaps in all, very slight, abortive forms, which can only be correctly interpreted when bearing in mind the prevailing epidemic.[1] The patients fall sick in the same way, very suddenly, with a chill, but the rise of temperature is only moderate; the pains, too, are not severe. Nausea is found to be always present, but never amounts to the vomiting of blood. Icterus is either wanting altogether or is not very intense. Sometimes it first shows itself after the disappearance of all the other symptoms. The secondary febrile movement never occurs. Here, too, convalescence lasts a disproportionately long time

CASES.

The following cases were observed on board H.M.S. Arcona, which left the harbor of Puerto Principe, Hayti, on March 21st, 1870, and sailed for Venezuela, in the Gulf of Mexico.

I. Schacht, seaman, a strong man of twenty-one years, blond, had never had any sickness of importance; he was often on shore in Hayti; on the evening of March 21st he still had a good appetite at meal-time, and went to rest feeling perfectly well. At midnight he awoke suddenly in his hammock, with a violent chill and difficulty of breathing. The next morning his face was quite flushed, the ocular conjunctiva much injected. Patient felt very weak, and complained of severe pains in the limbs. The tongue was covered with a thick greasy coat, there were loss of appetite, great thirst, and a sense of distress in the chest; patient had been constipated for two days.

Examination of the heart and organs of respiration revealed nothing abnormal.

Temperature:	8 A.M.	12 M.	6 P.M.
	102.6°	102.8°	103°

Pulse quickened, fully 116–120 a minute; ordered sick-diet.

[1] *Schmidtlein*, Deutsch. Archiv für klin. Medicin. IV. page 57.—*Haenisch*, idem XI. page 294.

℞. Hydrarg. chlorid. mit..... gr. iv.
Saccharl. albi..... gr. v.
M. ft. pulv. tal. No. IV. S. one powder every hour.

March 23. In the night he had two pultaceous stools; tongue red on the edges, with distinct impressions of the teeth. Gums swollen and bleeding slightly. Sense of pain in the epigastrium very distressing.

Temperature:	8 A.M.	12 M.	6 P.M.
	104.5°	104.2°	105°

March 24. Patient is excited and restless in the highest degree. All nourishment is vomited at once; slight jaundice makes its appearance. The urine gives the reaction of albumen and of bile pigment.

Temperature:	8 A.M.	12 M.	6 P.M.
	104°	103.8°	102.8°

March 25. The jaundice is increased. There have been from six to eight diarrhœal stools.

Temperature:	8 A.M.	12 M.	6 P.M.
	101°	99.5°	98.8°

March 26. The great restlessness has given way to a remarkable apathy. The sensitiveness in the region of the stomach still remains. Vomiting and looseness of the bowels are subsiding.

Temperature:	8 A.M.	12 M.	6 P.M.
	101.2°	101.5°	102.8°

March 27. After rather a quiet night the patient feels decidedly better, in spite of the high fever, which still persists. Thirst still very great. Vomiting and looseness are to-day entirely absent; the sensitiveness in the region of the stomach is also diminished.

Temperature:	8 A.M.	12 M.	6 P.M.
	104°	103.5°	102.8°

March 28. There was free sweating at night and a refreshing sleep. The temperature has fallen, and the patient, though weak and exhausted, still feels quite improved. The tongue is clearing, appetite returning.

Temperature:	8 A.M.	6 P.M.	Pulse.
	99.5°	99°	80–84

March 29. His condition is further improved; convalescence has set in.

Temperature:	Morning.	Evening.
	99.5°	99.2°

April 22. Patient is so far recovered that he is discharged from the ship's hospital, and is again able to perform his customary duties as a seaman.

II. Posansky, seaman, of weakly constitution, had a fainting fit once about fourteen days ago, without any assignable cause, but has otherwise always been healthy for years. During the night of March 27th, without previous illness, he suddenly fell sick, with an ague fit and violent pains in the back and limbs.

Temperature:	8 A.M.	12 M.	6 P.M.
	102.5°	102.8°	102.5°

March 29. Frequent fluid evacuations from the bowels, great restlessness and feeling of anxiety; complete loss of appetite, accompanied with great thirst; tongue thickly coated, with red edges. In the night attacks of nose-bleed and vomiting of bloody matters; violent delirium. A peculiar cadaveric smell is perceptible.

Temperature:	8 A.M.	12 M.	6 P.M.
	100.5°	102.8°	104.2°

March 30. In the morning, fall of the temperature and improvement of the subjective symptoms. Albuminuria, and reaction of bile pigment in the urine.

Temperature:	8 A.M.	12 M.	6 P.M.
	100.°	100.2°	102.2°

March 31. Marked icterus; suppression of urine; repeated attacks of bloody vomiting. Patient lies in his hammock quite insensible, only occasionally sighs and groans aloud. Towards evening he fell into a deep coma, from which he never awoke. Death ensued with hiccough.

PATHOLOGICAL ANATOMY.[1]

Cadaveric rigidity occurs very early and is very pronounced. As a rule, no considerable atrophy or wasting of the muscles is appreciable.

The color of the skin varies from a bright yellow to a dark orange or mahogany color; the mucous membranes, too, have a yellowish tinge. In a series of cases various alterations of the external integument have been found, viz., petechiæ, larger ecchymoses, vesicular and pustular eruptions (Jackson), scarlatinous and erysipelatous inflammations (Rush), miliaria (Barton), boils and carbuncles (Arejula *et al.*), and gangrenous degeneration (Deveze).

The brain and its membranes, and also the spinal cord, as a rule, show no special alterations; at the utmost they are found hyperæmic. Bally and Cartwright assert that in almost all the cases in which they made autopsies they found an inflammation of the arachnoid in the lumbar and sacral regions, with abundant serous exudation. Besides this, Cartwright mentions a specific

[1] Since I have made no autopsies myself, I give in the following pages the anatomical results from *La Roche*, loc. cit., Vol. I. 383; *Alvarenga*, loc. cit., page 6; *Grohé*, Bericht über die Leistungen der Pathol. Anatomie a. 1861, page 48; and *Griesinger*, Infectionskrankheiten, page 88.

alteration, which he reports having found in the ganglia of the cœliac and hepatic plexuses, and which consists in an intense inflammation of the neurolemma. This, however, is an alteration which is also met with in several other diseases, while in many cases of yellow fever it is absent, so that it can in no way be regarded as specific.

The heart often appears pale and flabby, its muscular tissue being the seat of fatty degeneration and friable; sometimes, too, it is found normal. The pericardium often contains a considerable amount of serous fluid, having a yellow or reddish color. The blood contained in the heart is sometimes fluid, sometimes coagulated, of varying color and reaction. The coagula, which often reach far into the vessels, are yellowish, as also the endocardium and the inner coat of the great vessels. The organs of respiration exhibit no characteristic changes; hemorrhagic infarctions are sometimes found in the lungs, and ecchymoses upon the pleuræ; in rare cases more abundant serous exudations in the pleural cavities.

The most important and constant changes are observed in the abdominal organs; the mucous membrane of the stomach and small intestine, as well as that of the œsophagus, are found almost without exception in a state of acute catarrh; the separate vessels, especially the veins, are highly injected, distinctly turgid, and exhibit an arborescent ramification. Hemorrhagic erosions are frequently found in the fundus ventriculi; ulcerations very seldom. The whole intestinal tract is apt to contain a greater or less quantity of more or less fluid, often tarry blood. The lymphatic glands show no constant alterations.

The gross appearances of the liver present no important variations. Sometimes it is rather enlarged, sometimes normal, sometimes to a slight degree shrunken. Its color varies between bright yellow, nankin, butter and straw color, ranging from the color of café au lait to bright orange color; the yellow coloring is sometimes uniform, or more often exhibits a scattered arrangement. The liver cells are very pale, slightly granular, the nucleus concealed; they are filled with numerous fat globules, the latter often attaining such a size that a single one fills almost half a cell. The form of the liver cells is not changed. The

whole organ strongly reminds one of the fatty degeneration so often found in topers. (Leidy.[1])

The gall-bladder is sometimes larger, sometimes smaller than normal, and contains a varying amount of dark green or tarry bile; the mucous membrane of the gall-bladder often presents a decided injection of the vessels, sometimes punctate ecchymoses. The ductus cysticus, as well as the ductus hepaticus and choledochus, are almost always found free and pervious.

The spleen is only slightly, or not at all enlarged, and is of a darker color and softer consistency than usual; sometimes its parenchyma is slightly friable.

With regard to the kidneys, it is reported by almost every one that a swelling of the cortical substance, with partial fatty degeneration, is very often present. Small abscesses are often found in the parenchyma. Ecchymoses and evidences of catarrh are seen in the pelvis of the kidney, as also in the mucous membrane of the urinary bladder.

Either coagulated or fluid blood, not referable to menstruation, is always found in the ovaries and in the uterus (Hayne).

ANALYSIS OF THE SEPARATE SYMPTOMS.

If we consider the progress of the fever, its violent course, the numerous hemorrhages and the anatomical changes, we can regard the disease in no other light than as a specific poisoning of the blood. The most tenable hypothesis is the following, though it is as yet unsupported by positive microscopic demonstration. The elements which convey the yellow-fever miasm being introduced into the circulation, produce there certain specific changes in the blood, consisting in destruction of the red corpuscles. On this theory most of the symptoms are very easily explained.

The etiology of the jaundice would be that there was a solution of a part of the red blood-corpuscles, and a transformation of their hæmatine into bile pigment within the circulation; the jaundice would then have to be regarded as hæmatogenous. An

[1] From the descriptions of several authors one might be left in doubt whether a veritable fatty degeneration took place, or only a fatty infiltration. Still, the majority is in favor of the former process.

icterus from retention, which has been very generally assumed, is to be excluded, because the fæces do not lose their bilious color, and because it has not hitherto been possible to demonstrate any biliary acids in the blood, and these would necessarily have gone over with the coloring matter. It need not argue against an icterus from retention, that the ductus choledochus has always been found pervious on post-mortem; for this passage may be easily closed during life by a catarrhal swelling of the duodenal mucous membrane, an accident to which its anatomical arrangement renders it liable, but which, of course, could not be demonstrated after death. But it would be remarkable that duodenal catarrh in yellow fever should always induce icterus, while this diseased condition, of such exceedingly frequent occurrence in other connections, should in these instances run its course without any such result.

Supposing the blood to be decomposed in this way, as we assume, and the red blood-corpuscles to be in great part destroyed, this fluid will then, of course, lose its capacity for nourishing the tissues of the body in the normal way and for regenerating them. From this results a great friability of the walls of the vessels, such as we often see in many diseases, in which the blood has undergone qualitative alterations; and this, in turn, conduces to hemorrhages in the various parts of the body.

Such a defect of nutrition also explains the fatty degeneration of the liver cells and renal epithelium. In all pathological processes which interfere more or less with the nutrition of single parts, fatty degeneration occurs, followed subsequently by atrophy.

We observe an increased frequency of breathing in all febrile diseases, and this is explained in those cases, as well as in yellow fever, partly by the increased temperature of the blood. As a consequence of this the frequency of the pulse is increased, and the blood being forced more frequently through the lungs, increases the *besoin de respirer*. This furnishes the stimulus to the vital point in the medulla oblongata and the impulse to more frequent respirations is given. (Guttmann.) In part the destruction of the red blood-corpuscles operates in a similar way. The body must be sustained during sickness by inferior blood, less

rich in oxygen; to render this possible, the blood must frequently take oxygen into the lungs and give up carbonic acid. The result of this is increased frequency of the pulse and respirations.

The course of the fever is in the highest degree peculiar; first a paroxysm of three or four days, then an intermission of one day, corresponding to a remarkable remission of other symptoms, and finally a paroxysm of shorter duration and less intensity than the first. This can only be due to a peculiarity of the yellow-fever miasm. Wunderlich [1] has determined, by a long series of observations, that there is a range of the animal heat distinctive of almost all febrile diseases, as, for instance, of typhoid, typhus, and relapsing fevers, small-pox, measles, scarlet fever, etc. In all these cases, as likewise in yellow fever, the cause of this typical range of the animal heat must be sought in a specific operation of the corresponding infectious material. In the case of relapsing fever it is only very recently that Obermeier has succeeded in discovering spirilla in the blood during the febrile paroxysm.

The nervous lesions, delirium, and headache are referable to a uræmic poisoning, to the perverted nutrition of the brain, and hyperæmia of its membranes. The violent pain in the back Bally attributes to exudative inflammation of the lumbar arachnoid, which he never failed to find.

An easy explanation of the lingering convalescence is found in the fatty degeneration of so many internal organs, in the feebleness of the whole organism, due to the fever and hemorrhages, and in the material loss of albumen. One may well conceive that many weeks are needed to make good such important losses.

DIAGNOSIS.[2]

If we keep in mind the region in which the disease appears, as well as that from which it may have been introduced; if we look at the race and nationality of the patients, and the acute

[1] *Wunderlich*, Das Verhalten der Eigenwärme in Krankheiten. Leipzig, 1870.

[2] Compare *La Roche*, loc. cit. Vol. I. page 564.—*Griesinger*, loc., cit., page 99.—*Haenisch*, Deutsches Arehiv für klin. Med., XI. page 300.

characteristic course of the malady, we shall generally be in a position to form a correct diagnosis. There are, however, various pathological processes which present a certain resemblance to the disease under consideration, and therefore are liable to give rise to mistakes.

The first to be mentioned here are the severe forms of malaria. The chief points of difference are of an etiological character, and lie in the difference between the two miasms as regards facility of transmission, and in the circumstance that the malaria process is chiefly localized in the spleen, while yellow fever induces scarcely any perceptible changes in this organ. Then we have the typical course of the temperature of the body, and finally, if we are willing to judge from the effects of treatment, we have the striking efficacy of quinine in the malarial affection, while this drug has not proved useful in so marked a degree in yellow fever.

Again, relapsing fever and bilious typhoid may give rise to errors in diagnosis. But here, too, it will almost always be possible to arrive at a correct opinion by considering the etiological relations, by the absence or presence of special symptoms, and by the characteristic course of the fever. It is of the first importance to keep in mind that in yellow fever we very rarely, while in both the other diseases we always, have a marked enlargement of the spleen, and the liver too is apt to be enlarged.

If, therefore, under ordinary circumstances the recognition of yellow fever ought to present no special difficulties, still we must allow that cases may present themselves in which the physician is not in a position to speak positively at once as to the character of the disease. Suppose, for example, a ship has been in the tropics where yellow fever is prevalent, and has perhaps touched at an infected port, or has had direct dealings during its passage with another infected ship. Such a ship now returns to a neighborhood where yellow fever is not endemically prevalent. Should there be found among the crew or passengers patients who are decidedly jaundiced, who suffer from hemorrhages, in whom a sudden remission of fever occurs, or in whom uræmic symptoms are developed, and should these patients have previously suffered

from intermittent, so as to have been left with an enlarged spleen, under these conditions it would really be scarcely possible to fix upon a positive diagnosis at once between yellow fever and bilious typhoid. Their further progress will, of course, in such cases, make the diagnosis certain. The presence of an enlarged spleen in patients who have not previously suffered from intermittent is a positive diagnostic symptom.

PROGNOSIS.

As already mentioned, the danger of the malady varies greatly with the race, nationality, and last place of residence of the individuals attacked. And it has been observed in persons who are but little predisposed, that, when attacked, the course of the disease is generally mild.

In any event, yellow fever belongs among the most destructive diseases, although the mortality from it varies very widely in different epidemics. Thus yellow-fever epidemics have been observed in which only fifteen per cent., and others in which seventy-five per cent. died.[1] But the mortality not only differs in different epidemics, it varies even in the different periods of the same epidemic.

The employment also, as stated above, and the situation of the dwelling occasion essential differences in the mortality, and these must therefore be borne in mind when making the prognosis.

It has been proved, in almost all epidemics, that there is considerably more sickness and death among men than among women and children.

Thus, in Lisbon, in 1857, there were 4,043 male and 1,118 female patients out of 5,161 who were treated in the yellow-fever hospitals. 3003 of these patients were from ten to thirty years of age, and 893 of them died. (*Alvarenga*, loc. cit., pages X. and XI.)

But the cause of this would be found less in the difference of age and sex than in the fact that the men, on account of their

[1] Compare *La Roche*, loc. cit., Vol. I. page 513, and *Griesinger*, loc. cit., page 99, § 139.

calling, as for instance seafaring men and soldiers, must be much more frequently exposed to the danger of infection than women and children are.

Among the individual symptoms the vomit especially is of evil omen. Louis noticed in Gibraltar that it was absent in only a single fatal case; while on the other hand it is established that only a very few of those who suffer from it recover.

Nevertheless Alvarenga, in the Lisbon epidemic of 1857, observed 40 recoveries among 178 cases of black vomit. Yet this experience remains quite isolated.

Bally bases his prognosis on the degree of albuminuria in the second stage of the disease (he never observed it in the first stage). If the quantity of albumen diminishes, the patient is advancing towards recovery; if it increases, a fatal issue is to be feared; if it is wholly wanting, convalescence takes place at once. Alvarenga, too, considers the greater or less quantity of albumen contained in the urine as of importance in prognosis, but not till the third stage. This rule cannot be regarded as certain.

TREATMENT.

The prophylactic measures which serve for protection against yellow fever must be administered by the state; but, on the other hand, every individual, if he is otherwise in position to do so, may secure himself against the disease by following certain rules.

The government ordinances must extend to a strict police supervision of the houses, streets, and harbor, in places where the disease is endemic, and in other districts they must seek to prevent the importation of the poison by the enforcement of quarantine regulations. It is not possible, absolutely, to prevent an introduction of the yellow-fever poison even by a strict quarantine. To accomplish this, the same judicious laws would have to be in force in all ports, and even then it would be possible to establish communication between an infected ship and the shore by means of boats at unguarded points; and then there is always the possibility of conveying the poison by land from an

infected port to one hitherto free, by means of goods sent by rail, or by means of the personal effects of the men. But this would in any event be only exceptional, and there need be no question that important protection is to be gained by wise quarantine regulations.

It cannot come within the scope of this article to give a scheme of international quarantine law against yellow fever; I can only emphasize a few points.

In regions where the circumstances so often rehearsed are not present, or at most exist only at certain seasons, no quarantine at all is necessary, or only at those stated times.

Every ship must be subject to quarantine which has communicated with an infected port or an infected ship, even if no case of disease has occurred on a voyage of some weeks' duration. That is to say, the human beings may possess no susceptibility to the yellow fever, may even remain healthy, and yet the poison of the disease conveyed in clothing, personal effects, cargo, or bilge-water, may have retained its capacity for infection. The object of quarantine here is to purify the ship thoroughly, to disinfect it completely in all its parts, its cargo included. In what way to accomplish this most efficaciously is not yet determined; perhaps by sprinkling with carbolic acid and by carbolic fumigations. The bilge-water must be pumped out, and clean water admitted at the same time, until what is pumped out appears clear and wholly free from smell. We may allow the passengers and crew to go ashore, provided they undergo a thorough disinfection with carbolic vapor as soon as they land; in fact, we may permit communication at once, if no case of sickness or death has occurred during the last two or three weeks of the voyage; whereas strict seclusion for two weeks will be requisite in instances where recent cases of the disease have occurred, for an incubation period of fourteen days has frequently been observed in yellow fever.

If there are sick persons on board when the ship arrives in port, we are urged by considerations of humanity, no less than of practical utility, to take them at once to a land hospital, after thorough disinfection. Since the disease is not contagious, the danger of a further spread of it cannot be increased by this step.

Should they remain upon the ship, however, the most favorable soil would here be supplied for the further development of yellow fever. Every consideration, therefore, prompts us to vacate the ship.

Quarantine will then, in the most favorable cases, have to last but the few days which are necessary for the disinfection of the ship; while in the most unfavorable it must be maintained for two or three weeks, since the period of incubation may last as long as that.

Persons who find themselves in the region of an epidemic may escape it, if they early betake themselves further inland, or to a neighboring mountainous country. In many cases it may suffice to abandon those quarters which are specially exposed to danger, and to remove to more healthy parts of the city.

If, however, men are compelled to remain within the circle of the epidemic, they should prudently avoid all those things which we have learned to recognize as occasional causes, without thereby giving themselves up to too great anxiety. The efficacy of prophylactic medicine is very doubtful, although quinine is highly commended for this purpose by Cummins, and mercury by Walker, of Jamaica.

The latter gained its reputation through a peculiar incident. On the occasion of the capture of Fort Omoa, the yellow fever broke out among the land forces, as well as on the fleet, and decimated the men. One of the captured ships was struck by a shot in such a way that the quicksilver, with which it was loaded, ran out of the vessels containing it. The sailors who were ordered to gather up the valuable cargo, did so, using their bare hands; and all who were employed in this way, during their stay in that region, remained perfectly well, although surrounded by sickness and death. (*La Roche*, loc. cit., Vol. II. page 762.)

Against the disease, when it has once broken out, the most various means have been employed, and in part recommended as specifics. Venesection has been used, vomiting and purging, mercury given to salivation, without any of these remedies proving effective.

We may certainly hope some day to find a remedy which shall as surely render the yellow-fever miasm harmless, as quinine, for instance, has done in the case of malarial poison. But until we have found this specific remedy, we are thrown back upon

a symptomatic treatment. This must not, however, be carried out on any fixed plan, but must fully recognize the individual peculiarities of each case.

At the beginning of the treatment, castor-oil or calomel is given in purgative doses to overcome the constipation which generally exists. If the pains in the back are very severe, dry cups or a blistering plaster may be applied in this neighborhood.

For the relief of the nausea and vomiting, bits of ice may be swallowed; and morphia, either internally or by subcutaneous injection in the epigastric region, is very highly recommended. It has proved very useful with me.

If one feels prompted to take measures against the fever, it will be best to make use of quinine, and it would certainly be most judicious to inject this substance subcutaneously, since, if introduced by the mouth, it would often be vomited again, owing to the great irritability of the stomach.

In case of copious vomiting of blood, we may try to give styptic medicines and ice internally, and may apply ice compresses in the region of the stomach, little chance as there is of success.

Since the whole course of the disease is rapid, we must remember, in regulating the diet, to sustain the strength as much as possible till the morbid process comes to an end. The difficulty of following this advice will be naturally very much enhanced by the great inclination to vomit, which is almost always present.

It appears to me very reasonable to try whether we may not be able to paralyze, or at least to modify, the injurious operation of the yellow-fever miasm by transfusion after previous bloodletting.

As soon as the stomach is again in condition to receive food and drink, we must seek to improve the composition of the blood by light nutritious diet, by wine, quinine and preparations of iron, and to remove any further morbid changes.

DYSENTERY.

HEUBNER.

DYSENTERY.

DIFFICULTAS INTESTINORUM. RUHR.

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HISTORY.

Even at a very early period we find dysentery a common disease, well known both to physicians and to the community. Herodotus gives an account of an epidemic of dysentery in the Persian army, as it was marching through the deserts of Thessaly,[1] and Hippocrates, both in his geographical pathology and in his writings on epidemiography, mentions this disease under the name of dysentery, which it still bears. It is evident from his definition of this title in the book on diet,[2] and from a passage in the Aphorisms,[3] that he was acquainted with the same disease which we call dysentery now, and had called it by this very name, which was, however, in the purely symptomatic terminology of the Hippocratic school applied to a great many other diseases as well. By the physicians that followed Hippo-

[1] Herodotus, VIII. 45.

[2] De victus ratione lib. III. cap. 5: Ubi calefacto corpore acria purgantur et intestinum roditur ac exulceratur, cruentaque per alvum demittuntur: hoc dysenteria appellatur, tum gravis, tum periculosus morbus.

[3] Sectio IV. 26.

crates it was restricted more and more in its application, and in the time of Augustus was used only for a single disease of the bowels with distinct characteristics. Even then certain features of the disease were well established. The name having been handed down through several schools of medicine, several traditional features came to be considered as characteristic of it; for example, the doctrine that it arose from acrid bile, that there were identified with it intestinal ulcers, tenesmus, bloody stools, etc.; and some of the descriptions are strikingly true to nature. Aretæus, for instance (A.D. 50), gives such a vivid account of the lesions that one would think he had made post-mortem examinations. The stools were carefully examined, and by means of them a differential diagnosis was made as to the seat of the disease. (This subject is studied with great insight and accuracy by Alex. de Tralles, A.D. 500.)

The treatment also was by no means unphilosophical.

Caelius Aurelianus, the translator of Soranus, gives the most extended description of the special pathology of dysentery, according to the accepted views of that time. He and Galen and Alex. de Tralles serve as authorities for the later writers down to the seventeenth century. Even after the beginning of the reformation in medicine, such men as Fernel, in describing the affection, followed in the footsteps of the ancients. The classification of the varions degrees of dysentery, of Fabricius van Hilden (at the beginning of the seventeenth century), follows Galen closely.

Only in the etiology do we meet with new views, such as the idea of the contagiousness of dysentery, especially by means of the stools, which had been unknown formerly. At that time there were frequently epidemics, which gave the better informed physicians opportunities for personal investigation, and for the first time knowledge was obtained of the dysentery of the tropics.

Lepois and De Lamonière describe epidemics from their own observation of them. An impulse was also given to original research.[1] The great Sydenham departs from the traditional

[1] A young Alsatian physician, *Gloxin*, writes in his dissertation on camp dysentery (Colmar, 1708): "Miscrorum aegrotantium lectulis me accinxi, ut ex ipso fonte quid haurirem, atque postea cum autorum quos evolveram observationibus conferrem; hisce enim solis nunquam fidi."

description of the disease in several particulars. From his observations during the London epidemic, 1669 to 1672, he concludes that dysentery is a general affection, a fever localized in the intestines, where the acrid juices of the blood pour out of the open veins, and give rise to the intestinal irritation. His treatment is directed to getting the acrid juice out of the blood.

These acrid juices play a prominent part in the etiology of dysentery from the time of the earliest observations to the nineteenth century. Even in Annesley we find the opinion that the acrid bile can so irritate the bowels as to give rise to a dysenteric affection. Only a few, among whom was the genial writer Stoll, did not take up this idea.

But the general knowledge of dysentery was becoming more and more thorough in the first half, and more especially in the third quarter of the eighteenth century, before Stoll's influence had been felt. Frequent epidemics springing up in middle Europe, now in one part and now in another, supplied abundant opportunity for study to the numerous observers of that truly Hippocratic period, to such men as Zimmermann, Degner, Mursinna, Pringle, Pauli, etc. It may well be claimed that the vividness and faithfulness of Zimmermann's descriptions have never since then been surpassed, and hardly equalled.

The different varieties in the course of the disease are recognized with great delicacy by all the above writers and aptly described, even though many erroneous statements of the pathological causes for these varieties are given.

At this time the investigations of Morgagni and Pringle, following Plater, Willis, and others, gave further insight into the nature of this disease. Morgagni showed that an inflammation of the intestine was present, and the affection was localized mainly in the large intestine; that the ulceration which had hitherto held so important a place was a secondary matter, and not really requisite for dysentery. This view Sydenham had already held, and Stoll confirmed it, and the idea was carried to such an extreme at the beginning of this century that the occurrence of ulcers in dysentery was stated to be very unusual.[1]

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[1] *Fournier* and *Vaidy*. Dict. des Sciences Méd. t. X. p. 320.

An essential advance in the pathology of the disease was made in this century, through the more accurate observations, in the tropics, of Bampfield, Annesley, Catteloup, and Prnner, and by means of the schools of pathology (Cruveilhier, Rokitansky, and Virchow).

O'Brien was the first, so far as I know, to bring up the idea of "pseudo-membranous" inflammation of the intestine. Rokitansky substituted croupous for pseudo-membranous, while Virchow called it diphtheritic. By this means dysentery came to be considered a specific disease, and often, indeed, as identical with diphtheritis of other mucous membranes, a view which is no longer tenable, considering the modern observations on diphtheritis of the fauces.

For the last ten years the subject has attracted less attention, because there have hardly been any epidemics of importance. Only after the late wars (the Mexican campaign, and more especially the Franco-Prussian war) have epidemics occurred which have given a new impulse to researches on the subject.

ETIOLOGY.

The dysenteric process is not, from an anatomical point of view, a specific affection. It consists of an inflammation of the intestine, of mild, moderate, or severe character, which, however, as far as we can judge from our present means of investigation, does not differ from what might be caused by poisoning with nitric or sulphuric acid, or arsenic.

Nevertheless in many cases dysentery cannot be regarded as a simple inflammation, like inflammation of the tonsils or pneumonia, because the development and propagation of epidemic dysentery show that the irritative causes which give rise to this particular inflammation are developed only under certain conditions, and hence may be considered specific;—we see that great numbers of men are made sick in exactly the same way, in other words, are "infected." On the other hand, the majority of cases of sporadic dysentery are surely to be considered simply as local affections arising from various noxious influences, although anatomically they are not distinguishable from cases arising from infection.

We must, therefore, distinguish between the *epidemic* and *sporadic origin* of dysentery, and will therefore begin with the epidemic variety.

Causes of Epidemic Dysentery.

The influence of climate on epidemics of dysentery is very plainly shown at the present time, when they so seldom appear in the temperate zones.

The disease finds its real home in the tropics. In all parts of the world which lie less than 35°–40° north or south from the equator, we find broad stretches of country where dysentery is endemic or epidemic.

In the same parts of India where malignant intermittent fever and cholera rage, severe endemic dysentery is also common.

Many regions of Asia, the Indian Archipelago, nearly all the explored coasts of Africa, the West Indies, and a large part of South America are dysentery countries.

In Europe endemic dysentery is found in the southern peninsulas, especially in Spain and Turkey.

In all these countries it is one of the prominent indigenous affections, and causes a considerable share of the general mortality.

Thus, according to the English physicians in India, every tenth man in the army, and in certain provinces every second man, has an attack of dysentery. The mortality from this disease amounts to 30 per cent. of the whole mortality.

In Ceylon 23 per thousand of the troops die of dysentery every year. In Cape Colony, in the year 1804–5, among the soldiers every fourth man was attacked with the disease, and of these 21 per cent. died. In Peru epidemics occur with a mortality of 60 or 80 per cent. (*Hirsch*, l. c., p. 197.) In Napoleon's Egyptian campaign 1,689 soldiers died of the plague, 2,468 of dysentery. (*Fournier.*)

It must be, then, that there is something peculiar in tropical climates favorable to the development of dysentery, and one cannot but suggest that the long-continued high temperature of the air and ground, on the one hand, favors the organic process which is the source of the dysentery poison, and on the other hand affects the human organism injuriously, in some way making it sensitive to infection. To a certain extent we also find

continued high temperature in connection with our northern epidemics of dysentery, for in many descriptions of them [1] it is expressly stated that the summer had been very hot during a large part of the year of the epidemic, or during several years preceding the epidemic.

At the same time a tropical climate and long-continued summer heat are not of themselves enough to develop dysentery. There are regions in the tropics where there is no dysentery, though the temperature is equally high (acc. to Hirsch, *e.g.*, in India the peninsula Guzerat, in Africa the country near the Senegal [2]). Besides, in the temperate zones the summer is sometimes quite hot enough in places where no dysentery occurs. In the dysentery countries, just as is the case here, the affection occurs at certain seasons of the year. In the tropics this season is the one in which, either from inundations or from rain, the ground and the air are very moist.

According to Annesley, dysentery rages in Bengal at the beginning of or during the rainy season; in Lower Egypt, according to Pruner, at the time of the overflow of the Nile. In the African tropics it also appears with the rainy season, and does not disappear before it.

The influence of the season is very plainly marked in the temperate zone, where epidemics occur in the latter part of summer or fall, and come to an end in winter.

This fact was noted by Hippocrates and Aretæus, and almost all the accounts of epidemics in the last century emphasize the same fact (Mursinna, Degner, Zimmermann, and others). Of 546 epidemics which Hirsch collected, 517 occurred in summer and fall, 13 in winter, 16 in spring,—*i.e.*, fourteen-fifteenths of all the epidemics began in the summer months.

The fact that dysentery occurs in some parts of the tropics, and not in other parts, shows that not heat alone, but other factors also, go to make up the cause of the affection. Its occurrence in our climate could be referred to the heat alone, for one could say that it is just in summer and fall that the effects of long-continued high temperature are felt, were it not that epide-

[1] So in the epidemic of Herford, 1779 (*Mursinna*), of Plymouth (*Geach*), of Würtemberg, 1734 (*Hauff*), etc.

[2] It should certainly be recognized that such accounts of regions in the tropics free from disease are often of doubtful authenticity. Sehwalbe (Beiträge zur Kenntn. der Malariakrankh. Zurich, 1869) undertook, in the case of intermittent fever, to prove the incredibility of such accounts (loc. cit., p. 23–25).

mics have occurred when the spring and early part of the summer had been cold and wet.[1] Heat alone, then, is no longer considered as the only predisposing agent in the development of dysentery; but its occurrence is to be attributed rather to cold nights alternating with warm days.

Pauli recounts an interesting example of sudden cessation of the dysentery in Mayence after a change of weather. An epidemic which had broken out there in July, 1793, and was slowly increasing, disappeared as it were in an instant while a strong west wind was blowing.

Of no less importance is the fact that the propagation of epidemic dysentery clearly depends on local causes. There are in the tropics certain countries, provinces, and cities where dysentery appears every year, and is of a very severe type; in other places it appears but seldom; in others it is never epidemic, and these very places lie perhaps in the immediate neighborhood of regions that are most severely attacked.

The peninsula of Malacca is very subject to dysentery; but the city of Singapore, situated at its southern end, is quite free from it (Hirsch). In St. Lucie (West Indies), on a mountain right in the middle of a swampy country full of dysentery and intermittent fever, there is no dysentery (Rollo). On the other hand, there are a great many tracts of country which are especially predisposed to dysentery, for the most part such as also suffer from malignant intermittent.

Such peculiarities in the behavior of dysentery, with regard to its occurrence as well as to its non-occurrence in certain places or regions, have been observed often enough also in our part of the world.

Sometimes the disease has taken its way through certain streets or certain parts of a city, sometimes it has halted suddenly in its march. At one time it has avoided those neighborhoods where at a former time it had raged; in other cases several epidemics have attacked the same places over and over again. Like peculiarities of place are frequently noticeable where armies have changed their camping-ground.

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[1] *Naumann*, Handbuch der medic. Klinik. IV. Bd. 2 Abtheilung. Berlin, 1835. Also the summer of 1870 cannot be counted among the remarkably hot ones. At the time when the epidemic began, there had been very wet, and, indeed, to a certain extent, cool days.

In a village of Lausitz a physician noticed that an epidemic affected one-half of the village as far as the church, and left the other entirely free (*Vogel*, Dissert., 1747[1]). In an epidemic in Saxony in 1797, villages at a distance from each other were attacked, while some, which were less distant and in closer intercourse, were spared (*Schröter*, Dissert., 1799). In Nimeguen the dysentery began both in 1736 and 1782, in the same house in Paul street, and spread thence in the same way (*van Geuns*). In some districts of Velau, on the contrary, the places which suffered severely in 1779 were spared in 1782.

With regard to camp dysentery, I would call attention to the statement of Mursinna, that while the army of Prince Henry of Hesse was encamped at Nimes, in Bohemia, in 1778, dysentery raged fearfully; but when the army moved to Leitmeritz, the disease immediately ceased, though the soldiers ate large quantities of fruit.

After the battle at Dettingen, in 1743, the English army encamped in a damp field at Hanau. Within eight days about 500 persons in the camp were attacked with dysentery.

At a distance of half a mile from the rest of the army, though otherwise in like circumstances, a few companies had a camp close to the river, and remained perfectly well (*Pringle*, loc. cit., p. 22 and 23.)

Frequently a marked improvement has been noticed in the dysentery cases when a camp hospital has been moved from an unfavorable place (*v. Dillenius*,[2] *Desgenettes*).

In view of these facts we must conclude that the cause of an epidemic of dysentery depends on a combination of various circumstances—a certain climate, a certain temperature, a certain season, and finally a favorable situation. An external source of disease affecting large numbers of people, developed in this way by external agencies and spreading within definite limits, we call a *miasma*, and so we may call epidemic dysentery a *miasmatic* disease.

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[1] The physician referred this fact to a "vapor crassus densus fœtidus et varie coloratus," which he had seen during his morning walk flowing over the village, going as far as the church, and then moving off to the woods again. Against this "vapor" he immediately took an antidote, and in this way succeeded in keeping himself well. A genuine old time belief!

[2] V. Dillenius had to march with a dysentery hospital of more than 500 patients from July 26th to August 3d, 1812, and it required four whole days to accomplish an ordinary nine or ten hours' march. The patients, extremely exhausted, were finally put into a sheep shed. Here, in the fresh air, and lying on hay, they all improved very quickly. By advice of the physician they ate for medicine the fresh whortleberries which they themselves picked. Loc. cit., p. 16.

In fact, however, the essential nature of dysentery is not brought to light by the facts that have been mentioned. Until very lately writers have had a strong predilection for seeking this so-called miasma in a certain putrid state of the atmosphere ("mephitis," according to Voigt), which is supposed to have come from the putrefaction of vegetable matter in moist, hot weather (Zimmermann); or from a fetid vapor formed in some way or other (Vogel); or from vapors out of the earth in case of earthquakes (Wittig, Geach, and others). Pringle tells of a severe attack of dysentery which came on after handling a bottle of putrid blood,—Fournier and Vaidy of a case caused by breathing the foul air from a battle-field covered with dead bodies,—Chomel and Blache of one caused by the miasma in a dissecting-room.

Rollo and others have with fairness objected to these cases, that it is questionable whether the affections of the bowels, which are well known to arise from septic infection, can with certainty be identified with dysentery; besides which, the marked localization of so many epidemics would exclude the possibility of infection by means of air-poisoning (Degner).

Attention has been turned with success, however, to certain peculiarities of the soil of those countries where dysentery is endemic. It has come to light that everywhere in the tropics there has been a close connection between dysentery and malignant intermittent and remittent fevers; that the fevers indeed in certain regions (Guyana) may make their appearance in the form of dysentery, and at times even with intermittent character (St. Lucie in the West Indies, Rollo). From these observations the suggestion naturally arose that the miasma of dysentery, like that of malaria, depended on vegetable and animal material in swampy land. Even the well-known passage of Hippocrates[1] suggests this idea, and various writers of the middle ages and modern times (Fabricius, Hildanus, v. Geuns, Geach), especially the observers of tropical dysentery, and even those who are content

[1] De aëre, aquis et locis, cap. III. : Quæ aquæ sunt palustres et stabiles et lacustres, eas per æstatem quidem calidas, crassas et olidas necesse est. . . . . Multæ intestinorum difficultates et alvi profluvia per æstatem incidunt, et febres etiam quartanæ, diuturnæ.

with purely mechanical causes for dysentery in special cases (Annesley, Rollo), come back finally to miasma from the ground, when it is a question of the etiology of the affection.

Even the dysentery of wars, which may develop so rapidly among large masses of persons when they change their position, does not contradict this idea. This dysentery is always dependent on situation. It develops itself only in such places as are peculiarly predisposed to it, as is expressly emphasized by military authors (Pringle, Mursinna). In the last war (1870), Virchow and Seitz rightly called attention to the fact that the dysentery developed into an epidemic chiefly in the camps around Paris and Metz; places that were already known to have been infested with endemic intermittent fever (*e.g.*, fortifications round Paris [1]) or dysentery.[2]

We may then adopt, as the cause of epidemic and endemic dysentery, a miasma, which is developed under the influence of a tropical climate, or of one resembling a tropical climate, in a soil of a certain moist and perhaps swampy character, in an analogous way with malarial poisoning; *i.e.*, under conditions which exist in some parts of the tropics every year,—in the temperate zones only from time to time. We must, however, not suppose that dysentery poison and malaria poison are identical, which is certainly not the case, for there are many fever regions where there is no dysentery (as on the peninsula of Guzerat in India), and *vice versâ*.

Indeed, we know nothing more of this hypothetical miasma than what has been said. We do not know whether it is gaseous or corporeal, etc. The parasite theory of Linneus, who considered dysentery to be itch of the intestine, had to be given up long ago. (Amoenitat. academ., vol. V., Dissert. 82.)

Basch (loc. cit. and österr. Zeitschrift für prakt. Heilkunde, 1868, N. 44) claims that in examination of intestines from cases of dysentery in Mexico, he found micrococci and mycelium in the villi and among the glands of the mucous membrane of both large and small intestines, as well as in the veins of the submucous coat.

I have never been able to find mycelium in the intestines after death from dys-

[1] *Trousseau-Niemeyer*, Med. Klin. Bd. III. page 341.

[2] *Gloxin*, Dissert., 1708. Praeloque, page 4.—*Marquet*, physician in Nancy, describes a severe epidemic of dysentery in 1734, in Viterne, in Lorraine.

entery here. It is true that I have often found in the mucous membrane, and also in certain parts of the submucous tissue (interstices of connective tissue) collections of small shining bodies, which were not destroyed by acids, alkalies, or ether, and which might be supposed to be micrococci, but they were not more numerous than are found in intestines put up in Müller's solution, and afterwards in alcohol, or than are found in fresh contents of the intestines.

Only artificial cultivation of these bodies could enable us to determine their nature with certainty, and for this I have as yet had no opportunity. For this reason I shall not return to the subject when speaking of the pathological anatomy.

Contagiousness.

Another question, practically very important, is whether the dysentery poison is transferable from one person to another, *i.e.*, contagious. The question is only with regard to epidemic dysentery, since the sporadic form is recognized as not contagious; this is why formerly, instead of saying epidemic and sporadic, they used to say contagious and non-contagious.

Opinions are divided on this point, just as they are with regard to typhoid fever and cholera. Of the best epidemiographists, only Degner favors its contagiousness. (Investigations at Nimeguen.) Here the disease, originating from one source, spread from street to street, and from ward to ward, through the town. Physicians and nurses were also attacked. Geach observed something of the sort at Plymouth.

The majority of observers deny, though reservedly, that it is contagious. Mursinna relates that at Herford no physician nor clergyman nor nurse was affected. Van Geuns says of the Harling epidemic that, although the soiled clothing and bedding of those that had died of the disease were sold to other people, no one had taken the disease from them. Zimmermann and Rollo, later Annesley and Hauff, do not consider the disease as originally contagious. All say that it becomes contagious later in the course of the epidemic, especially when great numbers of patients are collected in a small space (examples are given by Mursinna, Pringle, and others). In these cases they claim that a person takes the disease not directly from another person, but from the dejections of the patients (privies, instruments used in common, etc.)

Similar are the observations made in the war of 1870. In the great reserve hospital No. 1, in Leipzig, where out of 600 or 700 patients about 200 or more had dysentery, no single case of undoubted contagion occurred. Seitz relates a like experience in the Munich hospital. On the other hand, I have been told by several trustworthy army physicians, that in the field, where they were often obliged to heap together many severe cases in a small space, infection very often occurred by means of the privies, until stringent measures were taken to avoid it, after which it did not occur again. In the hospitals at Metz, too, it is reported that both physicians and nurses were affected (Seitz).

It would seem, then, that there is a limited contagion by means of the excreta of dysentery, which, however, only becomes active when a large mass of excreta is collected together. It is not impossible that small quantities of the miasmatic poison are discharged in the stools of the patients, and when collected together in sufficient quantity can poison new subjects.

As a preventive measure every dejection must be (as Bamberger wisely says) considered as dangerous.

Whether dysentery can be carried any considerable distance must still be left an open question. Single statements in reports of epidemics would indicate that it can be so carried. Degner mentions several cases (loc. cit., pp. 8 and 9) where the dysentery poison was brought into Nimeguen by visitors who came from houses in neighboring villages that were infected. Fournier and Vaidy relate that it was brought to the Ostende hospital by sick soldiers in the year 1794 (Dict. des Sc. Méd., tom. X. p. 342), etc. In a general way, however, the fact that dysentery among soldiers almost never spreads to the civil population, is against the possibility of its being carried any great distance (see many examples from Napoleon's wars, in Dict. des Sc. Méd.).

In the last war, too (1870), no epidemics which sprang up among civil populations had their origin among the soldiers. It is remarkable, certainly, that in 1871 and 1872 several epidemics of the disease were observed; in 1871 in several villages round Leipzig, in 1872 in Ludwigsburg (Dr. Seegen), and in the grand duchy of Oldenburg (Kelp).

Causes of Sporadic Dysentery.

Sporadic dysentery, which occurs in all sorts of places, in

adults as well as in children, must be regarded as arising from local causes, and, with regard to its etiology, as essentially different from epidemic dysentery, just as sporadic cholera is different from Asiatic cholera.

We can, however, understand that whatever causes give rise to it, must be of importance as predisposing to, or intensifying epidemic dysentery in so far as they give rise to inflammation of the large intestine, and so prepare the ground for the seeds of the specific poison of the disease.

When we look at the first stages of dysenteric inflammation we see that the stream of pus cells is always directed towards the surface of the mucous membrane; that the first changes take place close to the lumen of the intestines; that, in short, it is on the surface of the lining membrane of the bowel that the poison makes its attack, and attention is next directed to the contents of the intestines which lie in contact with it.

Noxious Influence of certain Kinds of Food.

With regard to irritating food and ingesta of all kinds, it was pointed out even by the ancients (Archigenes) that rotten eatables and "poisoned" drinking-water could bring on dysentery. Fabricius van Hilden gives a long list of drugs, drinks, and impure articles of food which give rise to the affection. Especially is unripe fruit considered as a frequent cause.

Many other writers (especially Stoll, and later Trousseau) believe that these things have no such effect. It is certainly not to be denied that acid, salty, or foul products of decomposition may be formed from food in their course through the stomach and bowels, and may irritate intensely the intestinal mucous membrane. The fact that, nevertheless, some very irritating substances do not succeed in irritating the bowels severely, is accounted for by the other fact, that any irritating substance causes a lively peristaltic action of the intestines, by means of which the objectionable substance is soon expelled.

The cæcum and large intestine, especially the lower part, are certainly the places where, under normal circumstances, masses are most likely to remain for a length of time, and these parts

are therefore especially liable to suffer from any irritating substance in their contents. If, then, there exists any torpidity of the intestines, these masses, which are perhaps intensely irritating, will be likely to remain still longer in those parts of the bowels, and really set up inflammation of the superficial mucous membrane.

Torpidity of the bowels plays an important part in the etiology of the disease in another respect, viz., the normal fæces also remain a long time in the bowel, and could occasion such an irritation as to give rise to dysentery in an intestine already perhaps affected with some catarrhal disturbance. This very circumstance has been recognized by physicians in the tropics as especially disposing to the disease. Rollo (1787, from his observations at St. Lucie) says: "When an inflammation has once been stirred up, it is certain to be increased by the scybala, which are pressed against the inside of the intestine, especially in the irregularities of the large intestine;" and Annesley (loc cit., p. 399): "That numerous cases of dysentery indeed commence with the characteristic signs of morbid accumulation in the large bowels, has been a matter of daily observation in my practice amongst persons recently arrived in India." Lately Virchow has (Arch., Band V. p. 348) called attention to this circumstance. He shows how a disease analogous to dysentery very often arose in a part of an intestine above a contracted portion, where the fæces were obstructed.

This mechanical irritation is certainly of great importance. Of itself it is indeed not sufficient to occasion dysentery, but is doubtless quite able in many cases to turn into dysentery a catarrhal affection which had arisen from some very different source.

On the dead body the different stages between the two diseases can often be made out, especially in those portions of the bowels where (as Virchow properly remarks) the fæces are well known to be delayed for a considerable length of time, viz., the cæcum and the flexures.

This condition is very apt to be present both in tropic and army dysentery. Warmth is very effective in diminishing the activity of the peristaltic action, and it was a matter of great

astonishment in the last war (1870) to see to what an extent the fæces could be accumulated in the bowels of the soldiers.

These observations show that this retention theory gives important hints with regard to therapeutic measures.

Another question, which was especially discussed in former centuries, is whether the natural fluids of the body can themselves become so diseased as to irritate the intestines sufficiently to bring on inflammation (Galen's "acrid juice" from bile; Sydenham's "acridity" arising from fever, etc.).

We have no proof that bile or any other secretion of glands can undergo such changes as to be irritating to the mucous membrane, and must therefore leave the question undecided for the present.

Annesley connects one form of dysentery of the tropics with disturbance of bile-secretion, and calls it hepatic dysentery. Under the influence of the tropical heat, as he says, the functions of the liver and the manufacture of bile (perhaps also of all the intestinal secretions) are interfered with, and thereby occurs an abnormal decomposition of food (fatty matter) which supplies the irritation from which the dysenteric inflammation arises. In addition to irritants applied directly to the mucous surface of the bowels, external influences may affect the bowels through the abdominal wall. The effects of exposure of the abdomen to cold may be transmitted to the intestines, and under certain circumstances cause an inflammation, which at first, to be sure, would be of catarrhal nature.

Exposures of this sort occur to soldiers who bivouac on cold, moist ground after hot days, or to any one who throws off his clothing in a warm night and then becomes chilled (In the Tropics, *Annesley*); or to washerwomen who stand for a long time holding wet clothing close to the abdomen (such a case came under my observation).

In such cases as these the peritoneum, and then the muscular coat of the bowels, and only then the mucous membrane is affected; and those authors who believe in a "rheumatic" dysentery report that it is attended with severe colic pains (especially Stoll). Some writers (Cullen, and especially Fouquet) go so far as to consider the spasmodic contraction of the muscles

the primary disease, to which the affection of the mucous membrane is but secondary.

If this is too bold an assertion, certainly it is not to be denied that the spasmodic contractions of the muscles have some influence on the congestion of the mucous and submucous tissues, and it is possible that thereby a catarrhal affection which has arisen from another cause might be increased. The dysenteric affection, of course, can only be said to have been caused by exposure to cold, together with some other cause of disturbance (constipation).

From this sketch it is evident that sporadic dysentery is caused by the co-operation of several injurious influences, which singly would only give rise to a catarrhal affection, and that in every case the indolence or spasm of the intestinal muscles is of great moment.

Individual peculiarities appear to be of little or no importance. The disease attacks persons of all ages, both sexes, and every station in life. Sickly persons seem to be attacked by preference. Drinkers suffer from it very severely.

Secondary dysentery is to be regarded in the same light with other parenchymatous inflammations (*e.g.*, of the parotid gland or of isolated portions of the skin) which follow severe, and espe cially constitutional diseases.

Stagnation of blood in the pelvis, and hyperæmia resulting from it (for instance, in case of excessive weakness of the heart after a patient has been in bed a long time), may well be at times the cause of the localization of dysentery in the deep-lying, large intestine. In such cases, also, it is quite likely that in the beginning there is a catarrhal affection of the large intestine, which, under continued unfavorable conditions, develops into the exudative form.

PATHOLOGY.

Sketch of the Symptoms.

It is impossible, in speaking of the symptoms, to distinguish between epidemic and sporadic dysentery. For this purpose we can only look to the severity and extent of the disease, and

these are often very considerable in the sporadic form, and in certain cases of the epidemic form but slight, although it must be allowed that the lighter affection (catarrhal) belongs, for the most part, to the sporadic, and the more severe affection (diphtheritic) to the epidemic dysentery.

The disease commonly begins with simple diarrhœa. For one or two days, or even up to fourteen days, there occur daily from two to six yellow or brown stools, with moderate abdominal pain, after there had been for a time irregular dejections or even constipation.

The appetite is usually but little disturbed, though in some severer cases there is at the outset complete anorexia, or one or more attacks of vomiting. The general disturbance amounts to a certain degree of lassitude. The patient remains out of bed, and in many cases attends to his usual occupations.

On the third to fifth day the diarrhœa becomes suddenly (generally in the night time) more severe. Chilliness and heat, or a rigor, general discomfort and weakness, usher in this stage. The abdominal pain becomes more severe, and occurs more frequently and in violent attacks. The desire to go to stool becomes so violent that the patient can resist it but a few minutes, although it is now no longer relieved by the evacuation of a large quantity of fæces. With violent straining and burning pain in the rectum (tenesmus) only a small quantity is pressed out. The discharge is still partly feculent, but is watery or mushy, and contains a good deal of mucus, which lies in the vessel in the form of a tough, gelatinous mass, often striped with blood, or floats in the fluid in transparent shreds.

The patient rises from stool with no sense of relief, only to be tortured in a short time with pain and tenesmus, and again to resort to the night-stool for relief. This process is repeated through the night at longer or shorter intervals, so that a patient may seek to evacuate the bowels ten or twenty times, in severe cases from forty to sixty, or indeed as many as 100 times in one night. The feculent character of the dejecta now quickly disappears, and only bloody mucus or pure blood is discharged.

In the midst of clear, reddish mucus are found little white opaque clumps, or, after the disease has lasted several days, the

dejections consist of reddish serum, containing round bits, looking like minced raw meat (lotio carnea).

Partly with the violent, continual pain, and partly with loss of blood and albumen, the strength is so reduced that the patient can hardly sit upright, but sinks back exhausted in his bed after each of his frequent visits to the night-stool. Often during this stage, which is sometimes very long, the patient has attacks of fainting. The face becomes pale, often with a tinge of yellow, and is indeed at times icteric (bilious dysentery). Moderate remittent fever comes on; the pulse still remains strong; while headache, dizziness, ringing in the ears, entire loss of sleep, want of appetite, and parching thirst add to the patient's sufferings.

In moderately severe cases the disease lasts from six to eight days. The forenoons are comparatively quiet, but towards evening and in the night the scenes above described are repeated. Every day the patient is more exhausted and thinner; every motion brings on pain and dyspnœa; the heart is weak, the pulse small, the extremities cool. The eyes become sunken; the tongue, at first white and coated, becomes smooth and shiny; the abdomen is generally but little enlarged, and quite tense, and is painful at various points. The skin around the anus becomes red, and strangury comes on with the tenesmus.

In lighter cases the tenesmus and pain diminish, while the abnormal stools continue, though they become less frequent, and begin again to contain feculent masses, which for many days have been wanting.[1] Generally there is now an alternation of mushy and even-formed stools (to which at most stripes of blood and mucus are found clinging) with pure bloody and slimy stools, which however are discharged with but little tenesmus; and gradually, in the course of from six to ten days, the discharges become normal. The appetite and strength return slowly, and in from one and a half to two and a half weeks the patient is convalescent, though the bowels continue to be quite sensitive.

In more severe cases the tenesmus keeps increasing in

[1] For this reason *Stoll* quite properly called dysentery a "morbus alvum occludens."

severity. The watery and feculent constituents of the stools are mixed more and more thoroughly with the blood, mucus, and pus, or the dejections become putrid, have a greenish-black color and an unbearable smell. Before long the patient cannot get out of bed. The dejections flow uncontrolled through the open and excoriated anus. Prolapsus ani, excoriations on the penis, and bed-sores result, and after eight or ten days a state of deep collapse comes on, with subnormal temperature, frequent, almost imperceptible pulse, sunken face, cold sweat on the livid extremities, livid lips and tongue, hoarse voice, præcordial distress, singultus, and partial spasms of the muscles. The patient gives out a putrid smell. But little urine is secreted. Consciousness is retained, and the patient dies from asthenia of the heart or from a secondary inflammation (gangrenous or putrid dysentery of the ancients).

Only so long as the collapse has not reached its worst stage is recovery possible, and always slow.

A third termination is in incomplete recovery—in chronic dysentery. In such cases there is only moderate collapse, and the disease keeps for a long time at the same degree of severity. Short periods of improvement occur, but are followed by periods of relapse. The dejection may cease to be pure blood, mucus, and pus, but the patient is left with chronic diarrhœa, and the stools generally consist of two layers of different quality, and certain round masses and shreds of mucus. With thin, feculent stools alternate discharges of pure pus. At times the fæces are formed, and at times only undigested food passes through the bowels (Lientery). In this way the affection lasts on over months, and even years, and gives rise to a terrible state of emaciation, anæmia, and exhaustion. The patient can hardly leave his bed, if at all.

Anasarca and effusions into the serous sacs appear. The abdomen is tympanitic or deeply depressed; the diaphragm is pushed upwards, and the respiration is thereby impeded; the appetite is poor, and, after months of sickness, patients die of exhaustion, or with pneumonia from collapse of the lung, Bright's disease of the kidneys, or peritonitis from perforation. Even in such cases recovery can take place finally, but great

sensitiveness[1] of the bowels lasts lifelong, and stenosis of the intestine, resulting from healed ulcers, may cause permanent invalidism, or death several years later.

PATHOLOGICAL ANATOMY.

The dysenteric process consists of an inflammation affecting the mucous and submucous, and in severe cases also the other coats of the intestine, and takes two different forms or (as some would say) grades, namely, the catarrhal or sero-purulent, and the diphtheritic or fibrinous.[2] It is necessary, before entering on the description of the anatomical appearances, to recognize these two forms or grades, which were first clearly described by Virchow. For, although in many cases one merges imperceptibly into the other, there are doubtless cases of purely catarrhal and others of purely diphtheritic[3] dysentery, each of which has its own course and mode of termination, and gives rise to certain anatomical appearances peculiar to itself, so that the lesions of dysentery can only be correctly understood when the two forms are studied separately. The discrimination is also of importance clinically, for the extremes of the two forms are practically, so far as regards their severity, two separate diseases. The accurate observers of former times very clearly recognized symp-

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[1] "Tam sagax est Natura," says *Fabricius*, "ut ab eo, ex quo aliquando damnum aliquod accepit, semper abhorreat."

[2] There is no unanimity of opinion among authors as regards the definition of diphtheritic inflammation (see *Wagner's* allgem. Pathologie, 5 Aufl. p. 287 and 288). Lately it has been said that the term should be applied only to such inflammations as are caused by micrococci (*Eberth*, Centralblatt, 1873, No. 19). In using the term here, I follow *Virchow's* definition (Virch. Arch., Bd. I. p. 253) according to which it is an exudation of close amorphous fibrine which is coagulated among the elements of the tissues and tends to necrosis. Such an exudation as this is really found in dysentery, as will be shown later. That micrococci have anything to do with the inflammation, I will not venture to affirm or deny. (See above, in the Etiology, p. 528.)

[3] This fact I would particularly emphasize in opposition to *Virchow*, who says (Kriegstyphus u. Ruhr, Virch. Arch., 52, p. 26), "Every dysentery is catarrhal at the outset." Those cases of dysentery where the whole intestine, from the lower part of the ileum down to the end of the rectum, is permeated with a continuous exudation, without any sign of an ulceration anywhere, must surely be regarded as rapid, primary diphtheritic affections.

tomatically the differences which we recognize anatomically, although they had not our anatomical knowledge. Their distinction between benign and malign, rheumatic and putrid dysentery corresponds to that between our catarrhal and diphtheritic. They knew also that simple rheumatic (inflammatory) dysentery can under certain circumstances become foul (gangrenous). Sporadic dysentery is chiefly catarrhal, and exhibits only the milder diphtheritic characters, while the true "primary" diphtheritic disease only occurs in epidemics, and must be due to some specific irritation, for it (the "fibrinous") cannot be called out artificially, though the other ("purulent") form is easily set up.

1. The *sero-purulent inflammation* (*catarrhal dysentery* of Virchow,—*follicular ulceration* of Rokitansky and Bamberger) begins with marked hyperæmia of the mucous and submucous tissues. Externally the intestine is not essentially changed, at most a distinctly reddish color shows through in certain places. After removing the contents of the intestine from the mucous membrane the latter is found to be covered with a moderately thick layer of hyaline mucus, streaked with red and easily washed off. The membrane is of deep red color, with numerous blackish-red points. The discoloration is arranged in patches and stripes, corresponding in the small intestine to the summits of the valvulæ conniventes, in the large intestine to folds made by accidental contractions of the muscularis mucosa. The membrane is in general more folded, and the villi in the small intestine are larger than normal.

The submucous tissue is only thicker in so far as it contains a number of enlarged vessels, and it therefore appears speckled and streaky. The muscular coat is normal.

With the microscope great numbers of capillaries are seen to be unusually large and plugged. Some of them come to the surface in the form of loops above the glands and villi (in the small intestine), others run along at the bases of the glands above the muscular layer of the mucous membrane. The diameter of the capillaries, measured on an alcohol specimen, is 0.03–0.05 mm. (0.0012–0.0019 inch). This enlargement is, however, only to be seen in spots. Every second to fifth villus, or interstice, has a set of enlarged vessels, and between them several glands are found lying closer together. The epithelial and mucous layers are not perceptibly

altered. The increase of room which is required by the hyperæmie membrane is obtained by numerous folds, which it makes above the normal level.

The submucous layer is distended by enlarged arteries (with a diameter of 0.1 mm. [0.004 in.]) and veins (0.4–0.5 mm. [0.016–0.020 in.]). The follicles are surrounded by garlands of enlarged capillaries. The fibrous tissue of the submucous layer is hardly altered. Its little bundles lie close together, while the nuclei of the cells which envelop them are seen projecting outwards at regular intervals.

The sero-purulent infiltration (second stage of catarrhal dysentery).

The mucous membrane is somewhat more swollen, paler, and of a whitish-red color, with red garland-like rings round the follicles, which appear as little white knots. Occasionally, where the swelling is considerable, there is a small hole in the mucous membrane, which leads into a little hollow over the follicle. This corresponds to the depression, figured by Kölliker (Gewebelehre 5te aufl., fig. 298 f.), arising from the absence of glands in the mucous membrane over the follicle. In dysentery the depression becomes a hollow, and gets filled with serum or mucus, when the mucous membrane around swells up.

The submucous layer is thickened three- to fivefold, and on pressure exudes a considerable amount of serous fluid. The muscular layer is also thicker with serous infiltration, and has a wavy outline towards the cavity of the intestine.

Under the microscope there is seen to be a diminution of the hyperæmia. The large infarcted capillaries are no longer, or seldom, perceptible. On the other hand, the interstices of the glands and the "basal membrane" of the mucous membrane are thicker in many places, and exhibit within the cytogenic membrane a much greater number of round cells than normal. These cells have a diameter of 0.007–0.01 mm. (0.0003–0.0004 in.), are granular, studded on the periphery with little fat-globules, and have generally a large threefold nucleus and a thin covering of protoplasma, *i.e.*, they are pus-cells. The mucus lying on the mucous membrane is stuffed full of such pus-cells, often half disintegrated. In many places the mucous glands are compressed—of some of them the blind ends are distended to cysts. The epithelium is not essentially changed.[1]

The *submucous layer* is 0.5–1.0 mm. (0.02–0.04 in.) thick and exhibits along the surface next the mucosa, and opposite the enlarged vessels, isolated groups of

[1] Rokitansky and Bellmont (loc. cit., p. 20) mention vesicular elevation of the mucous membrane. I myself have never seen it.

the same round cells with which the mucous coat is infiltrated. These groups are found more especially near the follicles, which are plainly enlarged, and for the most part oval, with the longitudinal axis parallel to the surface of the mucous membrane, the peripheral lymph-sinus large and free from pus. The pus is found mainly around the apex of the follicle, so that the muscularis mucosa, which covers it in and forms the base of the hollow in the mucous membrane above mentioned, is often crowded with pus-cells and near to bursting. The *fibrous tissue of the submucous layer* and its *cells* (endothelium) are in this stage not essentially altered,—the fibrous bands are somewhat swollen, but the enlargement of the coat is chiefly due to the effusion of albuminous fluid into the spaces. In the *muscular coat* also small collections of white blood-corpuscles are found along the vessels.

This stage is reached by the majority of light cases of dysentery, and the discharges, etc., may be perfectly characteristic of the disease. Complete recovery may follow, if the disease has advanced only to this stage, from cessation of the inflammatory swelling and absorption of the pus.

Purulent softening of the mucous membrane (third stage of catarrhal dysentery). The mucous surface now presents an irregular appearance.

On portions of the intestine, of greater or less size, are found, on a reddish or yellowish-brown level, great numbers of bluish-red or dingy islands, quite flat or plateau-like, with irregular edges, of various sizes, and often covered with a gray or greenish pellicle. Though they look like deposits of some sort, they are really remains of the mucous membrane, which is more or less destroyed by suppuration, and they are elevated above the surface like the last patches of snow left in the fields in spring. The pellicle covering them consists of a tough mucus containing perhaps fibrine, which can be stripped off without injuring the glandular layer. The homogeneous plain, on which these elevations stand, consists of the submucous layer stripped from the mucous coat, and often still covered with the muscularis mucosa.

The changes around the follicle give a very characteristic appearance to the submucous layer. The capsule of the follicle itself is opened by the suppuration (which began in the second stage of the disease), and thus in many places round holes are seen leading into cavities in which the follicle itself may be found as a necrotic plug. The mucous membrane around the follicle, however, is spared by the suppuration for a long time,

and forms a garland which has the appearance of a deposit around this crater-like opening. Later, this garland sloughs off with the submucous lying under it, and the follicle falls out, leaving behind the lower half of the capsule, which makes a little depression, and finally is itself destroyed by suppuration.

The submucous layer is at this stage more thickened and firmer.

The muscular layer is swollen and œdematous, and partially infiltrated with pus.

The microscope shows that this superficial destruction of tissue, which breaks down the mucous membrane in flakes as it were, arises from excessive suppuration. The patches of membrane which escape are found infiltrated with pus-cells which compress some of the glands together and push others apart. Then the vessels that go up through the membrane are compressed; the pus-cells and gland-tissue combine to form a detritus (in which remains of glands are found) and are thrown off. No fibrinous exudation into the mucous membrane (which is very easy to see in diphtheritic dysentery) is found in these cases, and I can therefore not agree with Virchow when he (Kriegstyphus und Ruhr) calls this loss of substance a *diphtheritic erosion.* The tissue of the mucous membrane is so delicate and loose that its destruction can only be attributed to excessive suppuration.

The follicles themselves are, properly speaking, not destroyed by suppuration. They are found crowded with round cells; the apex of each is welded to the muscularis mucosa by purulent infiltration; the rest of its surface is included by a broad, empty space (lymph sinus), and if the suppuration has opened this space the follicle itself is found within, either broken into bits or unbroken in the form of a plug of necrosed tissue. These plugs are much smaller than the "grains of sago" (Bamberger) found in the stools, and are by no means to be considered identical with them. Sometimes the peristaltic motions of the bowels seem to drive mucus and epithelium into these empty follicle cavities,[1] and little masses thus moulded may very likely appear in the stools as sago grains. The real follicle plugs disappear as detritus in the dejections.

The submucous layer is infiltrated with pus to a considerable depth (forming a true catarrhal ulcer). When the suppuration extends deep into the submucous layer, a fibrinous exudation is poured out into the deeper parts of the submucous coat, and the disease then first begins to be diphtheritic.

In cases where the ulceration has not become too extended, recovery may take place even after the disease has advanced to this third stage. The eroded patches become smooth cicatrices, devoid of mucous membrane, and on them, like islands, lie the

[1] *Cornil* lately described such a case (loc. cit.).

portions of mucous membrane which have escaped the disease. Later, however, the irregularities of surface gradually disappear.

2. *The inflammation with fibrinous exudation* (*diphtheritic inflammation* of Virchow; gangrenous dysentery. Putrid dysentery of the older writers).

In its purest form this kind of dysentery may be described as follows: The whole of the large and the lowest convolutions of the small intestine appear externally dark bluish-red. The fine vessels of the serous covering are injected, and the whole tube looks stiff and feels hard and solid. The lumen is rather diminished than enlarged, and contains for the most part a thin reddish fluid, and only at certain places fecal matter. Internally the bowel presents a reddish-white, uneven surface, continuous from the lowest part of the ileum to the rectum, but patched with a great variety of crooked figures of blackish, greenish, or dark-red color, which lie close to each other, looking now like the mountain chains on our raised maps, now like frozen waves, now like the convolutions of the brain, and among them lie deep furrows and cracks.[1] On the longer ridges again are found little miliary elevations, and altogether the whole presents a variegated appearance which in no way resembles mucous membrane. On cross-section the walls of the intestine are found excessively thick, but in them can be distinguished only two layers: the thicker one being the muscular coat, which is puckered inwards in many folds, and over it a stiff homogeneous tissue, partly yellowish and partly reddish, which offers considerable resistance to the knife. At the places where the furrows and cracks between the raised portions above mentioned are situated, there is seen, on cross-section, only a small quantity of distorted tissue lying on the muscular coat, which is the remains of the mucous and submucous coats that have atrophied from pressure.

Closer examination shows that the mucous and submucous coats are, as it were,

[1] It was this very severe form of dysentery which so astonished *Pringle* (loc. cit., p. 290), and which he compared with confluent small-pox. *Cruveilhier* figures it under the name pseudo-membranous dysentery. We have here, however, not a membrane which can be peeled off, but an exudation surrounding and permeating the whole tissue (Voigt).

transformed into an enormous extravasation, consisting chiefly of blood, less of pus, and of a stiff, amorphous, fibrous exudation. The foreign substances fill up all the interstices between the tissues, and, indeed, so completely squeeze up the original membranes that hardly a trace of the normal structure can be found. In place of the mucous membrane there is now a gray, moderately homogeneous mass, and a large collection of extravasated blood. Only on very thin sections are the glands seen in the midst of this mass, in the form of elongated and narrowed double rows of epithelial cells, which, to a certain extent, have the look of little enclosures of a foreign substance, around which in every direction lies the extravasated mass. On thin sections of this mass, that have been carefully shaken out, a network can be discovered, consisting of fine and coarse shining fibres. This appearance of a network arises from the removal of pus and blood-corpuscles that had been crammed in the mass like berries in a pudding.

The submucous coat is exceedingly thick, four to six mm. (one-sixth to one-fourth of an inch) in thickness at many points. The interstices in its tissue, which can be stretched out, are enlarged to enormous spaces, and completely filled with effused blood. The parallel bundles of fibrous tissue are so torn and pushed out of shape that they now run lengthways, and also look like something foreign to the tissue enclosed in it.

By carefully brushing and shaking out sections of this hemorrhagic mass, we find here also a coarse network of fine, lustrous fibres, of yellow color. In non-hemorrhagic parts we find simply this network moderately well filled with pus and lying in the interstices of the fibrous tissue. Similar networks are found along the vessels of the muscular coat, and also strongly marked in the interstices of the fibrous tissue of the serous coat.

This fibrous substance exhibits great resistance towards acetic acid (a long immersion only sufficing to swell it up), hydrochloric acid, and ether. In a cold caustic solution of potash it becomes clearer; and in a boiling solution it dissolves. We have, then, before us a hard, fibrinoid substance, arising from the blood, and possessing great chemical stability, which lies in the tissue as a dead mass, and completely crushes it, when the exudation is carried to so great an extent as has just been described.

Parenchymatous changes also occur in the fibrous tissue of the submucous coat itself.

The parallel trabeculæ of the submucous fibrous tissue, like those of the subcutaneous fibrous tissue (Flemming), and of the tendons (Ranvier), are clothed with exceedingly delicate flat cells (fibrous tissue corpuscles, endothelium). They may be seen very clearly by means of carmine-water on the submucous of guinea-pigs freshly prepared. On the intestines of man they commonly appear (from ten to fifteen hours after death) only as large nuclei clinging to the bundles of fibres, and covered by a quantity of very delicate pale protoplasma, with a zigzag outline.

In catarrhal dysentery there is no essential change to be seen in this fibrous tissue. On the other hand, as soon as the diphtheritic exudation is effused into the interfibrillar spaces the trabeculæ swell up, lose their normal lustre, and become

broad bands with dull surfaces. The endothelium is also much swelled. Fine sections from fresh specimens of intestine, hardened in Müller's solution, and then in alcohol, and afterwards thoroughly shaken out in Müller's solution, show, on the one hand, on the separated bundles of fibres, large and delicate plates with long processes, and, on the other hand, large bodies arranged in rows along the bundles, for the most part oval and angular, sometimes with and sometimes without nuclei, evidently coming from the degeneration of the swollen endothelium.[1] They are 0.03–0.04 mm. (0.0012–0.0016 in.) long, and 0.01–0.02 mm. (0.0004–0.0008 in.) broad.

Thus we see that a parenchymatous destruction of the original tissue takes place in this kind of inflammation, and is, perhaps, the first step of the later necrosis.

In this severe form of dysentery gangrene of the whole wall of the intestine is sure to follow, unless death occurs before the disease reaches this stage. Gangrene always occurs, however, when the diphtheritic inflammation is associated with the catarrhal in isolated sections of the intestine.

A combination of diphtheritic with catarrhal dysentery is the form of disease usually found post-mortem, especially in the cæcum, in the folds of the large intestine, and in the rectum.

Histologically speaking, we may say that the disease, being at the sero-purulent stage, is aggravated by a new[2] attack of hyperæmia. The vessels of the mucous and submucous coats, which are already infiltrated with pus, are again greatly enlarged, and the hyperæmia at the same time stretches out over a larger circuit to the vessels, namely, of the *serous coat* and to those of the *follicle*. In the latter many broad loops are seen traversing the tissue, and they are now involved in the morbid changes simultaneously with the whole submucous coat; for at this time the *fibrinous exudation* makes its appearance in the connective-tissue interspaces, and in and on the mucous membrane. At the same time such severe suppuration begins in the submucous coat that the *submucous abscesses* arise, which may destroy the mucous membrane from underneath, though it has not suffered on the surface. Hemorrhages in various places accompany the fibrinous exudation.

At the places thus affected the whole intestinal wall is thicker, and therefore stands out from the parts where the disease is only

[1] *Basch* (loc. cit.) saw and figured these bodies, and also considers them to have taken their origin from the fibrous tissue corpuscles. He thinks, however, that pus is formed from them afterwards, which cannot be the fact, because they are not present in simple purulent inflammation, and are only formed in connection with severe disturbance of nutrition.

[2] I would consider this second hyperæmia as analogous to the hyperæmia which ushers in the suppuration of variola.

catarrhal; for this reason the surface is wavy or knobby, the color reddish-white, with dark-red points or stripes or,—from metamorphosis of pigment, or staining of the exudation by fæces,—greenish, brownish, or even black. As the disease goes on, gangrene appears in the portions where the exudation has put a stop to the vital processes. Patches of the mucous and submucous coats, and even of the muscular coat, from the size of a nickel cent to that of a silver dollar, change into black or yellow sloughs, which cling to the intestine in shreds for a while and are then thrown off. Or, portions of the diseased bowel are changed to a brittle granular mass, and, as the detritus is washed off, the loss of substance goes deeper and deeper into the intestinal wall. The parts thus laid bare consist of insufficiently nourished tissue, which in its turn is colored dark green or brown.

In other places the submucous abscesses destroy the support of the mucous membrane with long sinuses, forming ulcers over which the mucous membrane makes bridges. Thus we find side by side with the earlier-described shallow catarrhal or follicular ulcer in the thickened and infiltrated wall of the bowel, also reddish, green, yellow, or black sloughs, in many places covered with a gray pellicle; as well as deep, sharp-edged holes and furrows, which may undermine the tissue extensively, and, extending even to the serous coat, cause perforations; and again, we find collections of pus which have a yellow color showing through, and which on pressure discharge pus at various points at some distance; and fresh diphtheritic and catarrhal disease;—and it is from these changes that the variegated appearance of the bowels in dysentery arises.

The extent of the affection varies exceedingly. Frequently only the rectum, with the lower part of the sigmoid flexure, or perhaps the cæcum alone, is affected. The further the disease extends, the deeper into the tissue do the least recent parts of it reach.

When the whole intestine is affected, the oldest part of the disease is generally the lowest part, while the upper part is the later attacked. This is, however, only a general statement, for to a certain extent portions lightly and severely attacked succeed each other irregularly.

Recovery is possible in cases where the gangrene is still quite limited in extent. The edges of the mucous membrane, though more or less undermined, cling to the submucous coat, which throws off all the dead tissue, becomes covered with granulations, and then slowly cicatrizes, often making hard callosities. If, however, the loss of substance is widespread, there spring up long and broad, very irregular cicatrices, which contract and make bands and cords, thereby diminishing the size of the intestine at various points, while among them rise the healthy patches of mucous membrane-like islands or warts. In these patches the glands are retained, but the cytogenic membrane is changed to an ordinary connective tissue full of fatty detritus.

Chronic dysentery arises from persistence of the suppuration of ulcers left by sloughing, and of the catarrhal ulcers, and especially of the submucous abscesses which make long sinuses, and sometimes lead to perforation or to indolent inflammation of the connective tissue bordering upon the intestine.

Changes in other Parts of the Body.

The peritoneum of the inflamed intestine is in all severe cases strongly injected, and often throws off a puro-fibrinous exudation. Sometimes a local peritonitis becomes general, especially after perforation of the intestine. Often different portions of the peritoneum stick together, whereby threadlike adhesions are formed, which may cause considerable dislocation of portions of the bowels.

The mesenteric glands of the large intestine are swollen, reddened, and pigmented, and contain many abscesses, and when the dysentery has lasted long, also cheesy masses.

The stomach, duodenum, and upper part of the small intestine are either normal or in a state of catarrh. The latter is especially common in dysentery of the tropics.

The liver is, in tropical countries, in a state of intense hyperæmic swelling, or contains an abscess of variable size, the result of a circumscribed parenchymatous inflammation. In this part of the world, also, hepatic abscesses are observed after dysentery; they are, however, multiple, and of embolic source, and are

found in connection with periproctitic inflammation. The bile is not essentially changed. The spleen is, as a rule, small. In the kidneys the veins are congested, and in chronic dysentery the parenchyma is often inflamed.

In the lungs, as a result of protracted lying in bed, are found atelectasis and lobular pneumonia.

The heart is flabby. The amount of blood is considerably diminished, and hence all the organs are very anæmic. The whole body is wasted.

The brain is very anæmic and sometimes œdematous.

The reports of the Würtemburg physicians (Hauff and others) with regard to meningitis in dysentery must arise from false interpretation of the appearances arising from œdema of the subarachnoid lymph spaces.

In the skin, the serous cavities, and the salivary glands, in cases of long duration, are often found the so-called metastatic inflammations: purulent parotitis, pericarditis, pleuritis, pseudo-erysipelas, thrombosis of veins with puriform disorganization, gangrenous bed-sores, or noma.

ANALYSIS OF SYMPTOMS IN DETAIL.

Symptoms proceeding from the Diseased Organ.

The *discharges* show the most important signs of dysentery. They are changed in every respect.

The *frequency* of the stools alone is somewhat characteristic, there being more than in any other disease. In the lightest cases there are from twelve to twenty discharges daily,—in severe cases from fifty to sixty, and indeed sometimes as many as two hundred, so that the patient, in fact, never leaves the stool. This arises from the abnormal irritability of the mucous membrane of the rectum, the sensitive nerves of which, on account of the hyperæmia of the part, constantly give the sensation as if there were something there to be ejected. The frequency of the dejection, therefore, goes hand in hand with the severity of the disease in the rectum. They are not so frequent when dysentery begins in the cæcum, and only become more frequent when the disease

goes downwards (as for example in the epidemic described by Sydenham). Diminished frequency of the dejections is a favorable sign only when there is improvement in other respects, for it may arise from exhaustion of the rectum.

The quantity of the single dejections is strikingly small, and inversely proportional to the frequency. A single discharge often amounts only to a few drachms (from three to five).[1] The quantity of the discharges, taking the whole day together, is not so great as would be expected. According to my observations of the army dysentery in 1870, they amounted generally to from 800 to 1,200 ccm. daily (250 to 400 dr.). The small size of the single discharges arises from their being ejected by the peristaltic movements of the lower part of the bowel only. The contraction does not take place in the upper part of the bowel, or amounts only to a spasmodic constriction at certain points, which could not lead to a proper evacuation of the contents.

Of special importance is the condition of the discharges, which are so changed as to present very varied appearances, even though comparatively few substances are found in them ;—namely (besides fæces which are not found at all at the height of the disease), mucus, blood, pus, serum, and either detritus or (seldom) portions of intestine sloughed off, but still recognizable as such.

The most striking of these is the blood (red dysentery). It is, however, not an essential characteristic of the disease, for there are epidemics in which the dejections are only muco-purulent throughout (white dysentery), and at a certain stage of every case it may be absent. Its presence depends on the intense hyperæmia which ushers in catarrhal as well as diphtheritic dysentery, and on the greater or less amount of hemorrhages.

The great variety of the stools depends on the manner in which the constituents are put together, and on the stage of the disease. We may, in a general way, distinguish—

1. *The mucous or muco-sanguineous stool.* It consists of a slightly yellowish, glassy, quivering mass, which lies in the vessel in balls or clumps, without any fæces, or around a formed mass

[1] "The small amount of the discharges," says *Pauli*, of the epidemic at Mayence, in 1793, "was a matter of surprise to all who compared it with the magnitude of the preceding tenesmus and pain."

of fæces, with bloody points and streaks scattered through and over them.

This mucus gives the appearance, under the microscope, of a structureless mass with a few round cells and nuclei, and often flattened masses of epithelium. When the discharge is fluid, the masses of mucus unfold into hyaline transparent membranes and shreds, which float in the fluid portion of the discharge, whence comes the name *shreddy stool.*

Such discharges as these characterize the hyperæmic stage, and are formed mainly by hypersecretion and hemorrhage of the mucous membrane. They occur at the beginning of severe, and throughout the whole course of light cases.

2. *The sanguineo-purulent stool* (*lotio carnea*). In a small quantity of yellowish or reddish fluid, generally free from fecal matter, float a number of soft, yellow, red, or reddish lumps, as large as a pea or a bean, which bear a certain resemblance to raw minced meat. If the fluid portion is very thin, these bits are not transparent.

The fluid consists of an albuminous serum, and the lumps,[1] mostly of a thick, mucous network, closely crammed with red blood-corpuscles, and holding at many places clumps of the size of a millet seed (or larger), which are made up of pus, together with a few epithelium cells, often bits of food, fungous bodies, masses of bacterium termo, and detritus.

This kind of stool marks a more advanced stage, namely, that of suppuration of mucous membrane. Formerly the flesh-like lumps were supposed to be fragments of the intestine (since Hippocrates), but Morgagni expressed his disbelief of this view. It is certainly possible at times to find bits of mucous membrane, *i.e.*, a tissue marked with delicate dots, and containing remains of glands or a few whole glands. But they are not always to be found,—probably much less often than destruction of the mucous membrane, which usually occurs by its breaking up into detritus.

3. *The pure bloody stool.* This occurs either in the beginning, as a result of superficial hemorrhage, or later, from ulcera-

[1] Carunculæ of authors.

tion opening a large vessel, and in the latter case indicates loss of substance.

4. *The simple purulent stool;*—a larger or smaller amount of pure odorless pus evacuated as out of an abscess. This stool occurs only in the later stages of dysentery (especially in the chronic form), and always indicates either submucous abscesses or destruction of the mucous membrane.

5. *The gangrenous stool*, which consists of a blackish or brownish-red sliny fluid (by no means to be confounded with a stool colored with iron or bismuth, and at the same time purulent or slimy!) with a putrid odor, and containing larger or smaller pieces of gangrenous tissue which have sloughed off. It points to diphtheritic destruction of portions of the bowel, but does not occur in all cases of this kind in its most perfect form, because here too the necrosed tissue is often carried off in the form of detritus. The majority of the tubular structures which have been discharged, sometimes recorded as "a foot long," and considered to have been pieces of intestine, consist without doubt (as Zimmermann has already said) of mucus only.

Pruner reports a case which occurred in Egypt, where a piece of intestine a foot long, on which both the mucous and the submucous coats could be made out, was discharged. It is questionable whether there was not also intussusception in this case.[1] Annesley also considers the tubes of this sort to be mucus.

6. *The frogs-eggs- or sago-like clumps* in the discharges (corpora pinguia of the ancients), which have given rise to a great deal of discussion, consist of rather tough, round masses of hyaline mucus, and contain a few mucous cells, free nuclei, and epithelial cells. They are probably formed when mucus, which has been secreted late in the disease, is pressed into the cavities out of which the follicles have fallen, and having been moulded into shape falls out again into the contents of the bowels (see p. 541). They also sometimes arise from starchy food (Virchow).

The consistence of the discharges, made up of fæces and abnormal matters, depends on the rapidity of the peristaltic action, which is sometimes interrupted so that the fæces are not transmitted regularly, and only from time to time are the blood

[1] *Griesinger* reports two such cases (loc. cit., p. 686).

and mucus accompanied by a little lump of fæces. In other cases abundant watery fæces are discharged, of brown, yellow, or even light grayish-yellow color (catarrh of the duodenum). The green color arises from remains of food, or from a peculiar change in the coloring matter of the bile in the discharge (acid state of the contents of the intestine in certain parts).

In cases where fæces in small bits, closely combined with reddish, white, or yellow flakes, or with sago-like lumps of mucus, fall to the bottom as a sediment in the supernatant, reddish fluid, we almost always have to do with disease situated in the upper part of the large intestine and progressing upwards. (This was known to the older writers, as Galen and Alexander de Tralles.)

Subjective Symptoms.—The tenesmus, the most distressing and most constant symptom of dysentery, is either pain in the inflamed and sore mucous membrane of the rectum and anus, or painful spasm of the sphincter ani and neighboring muscles. The former is a burning pain, as if it were caused by red-hot iron, —the latter is connected with the constant desire for stool. The patient feels as if there were all the time a foreign body in the bowel, and continually tries with all his might to get rid of it, often causing prolapsus ani by his straining. The cupiditas egerendi brings but little fæces or mucus to the rectum, which in its turn is again irritated, and so it goes on in a circulus vitiosus. Severe pains, radiating out towards the sacrum and back, also occur.

Very often *tenesmus of the neck of the bladder* (the result of collateral hyperæmia of its plexus of veins) is associated with the tenesmus of the bowel. Every drop of urine, by reason of its concentration, sets up in the bladder, immediately after entering it, a painful burning and desire to void it.

Pauli's description of tenesmus is very vivid (loc. cit., p. 15): "Most of them were driven five, six, or even more times in an hour to relieve nature, and many were kept on the night-stool a quarter or half an hour by a distressing tenesmus, whereby they accomplished nothing, with the most distressing straining, but the discharge of a little white or bloody mucus, and then could not without great trouble bring into place the lower end of the bowel, which had prolapsed to a considerable length, or had become a thick, blood-red tumor."

The colic, *i.e.*, pain coming in separate attacks in the hypo-

gastric and epigastric regions, and preceding the discharges, arises from spasmodic contraction of the different parts of the colon (especially the so-called "stomach-pains," mostly from the transverse colon), and is even in light cases at times very severe, so that the patient breaks out in profuse perspiration and writhes with pain. At times the movement of the colon can be felt or seen.

A very ominous symptom (characteristic of the severe "gangrenous dysentery") is a sensation of *severe oppression in the gastric region.* It is generally associated with continuous singultus (likewise a bad symptom).

Objective Appearances.—The *anus* becomes bluish-red, and is often marked with cracks and rents. It is painful to the touch, and tightly contracted. In the later stages of severe cases it becomes large and gaping. Then the stools are generally discharged unconsciously, and the pain is slight, paralysis of the sphincter ani having occurred. These symptoms indicate generally that death is to be expected.

The *abdomen* is in most cases not enlarged, and but slightly tense. But few signs of disease can be seen on it. Very often the diseased portions have, on palpation, a peculiar sensation of resistance, like a rubber tube with rather thick walls, and the amount of disease can be estimated in this way by palpation. (Besides my mention of this fact[loc. cit., p. 433], Pruner also has remarked it.) Pain on pressure is also commonly found limited quite accurately to the diseased portions (not alone, as Stoll affirms, in the "inflammatory form").

An affection of the *peritoneum* is recognized by its characteristic symptoms,—swelling, hardness, exudation, etc.

The other parts of the intestinal tract are variably affected. The *tongue* generally has a thin, white coat; in some epidemics it is thickly covered with a pasty coat. In the severer cases it loses, later in the disease, its epithelial covering, becomes red and smooth, and finally dry, cracked, and dusky. The *palatal membranes* are sometimes inflamed, and may indeed have a diphtheritic deposit (Pauli).

The *stomach* is often catarrhal, and seldom inflamed. Von Dillenius reports that gastric ulcers have been found at post-

mortem examinations. In many cases of dysentery, however, the digestion of the stomach is but little disturbed, and under these circumstances the patient can be more thoroughly nourished during the course of the disease.

Vomiting occurs frequently at the beginning, sometimes also during the course of dysentery. The matter vomited consists of remains of food, and later of slimy masses stained with bile. Unusually severe and continued vomiting always indicates a more serious affection.

The *duodenum and jejunum* are frequently catarrhal, much less often diphtheritic. In case of severe duodenal catarrh, icterus occurs, which is especially often noticed in the tropics.

The urine is, in acute dysentery, scanty, dark, and concentrated, abounding in uric acid salts and uric acid. The chlorides are diminished. Albumen is commonly not present.

Concomitant Symptoms in other Parts of the Body.

The *febrile symptoms* in dysentery are relatively slight. In many catarrhal cases fever is entirely wanting, and there is only moderate constitutional disturbance of any kind. In gangrenous dysentery, too, the temperature is not elevated at the time of the severe symptoms, but, on the contrary, abnormally low. Only the moderately bad cases, viz., the severer sero-purulent cases with partial diphtheritis, are characterized by remittent fever, —with evening exacerbations from 102.5° F. to 104° F.—which passes of by lysis, but returns again to a certain extent, with every relapse of the local affection. Here belong those dysenteries which are designated as "inflammatory;" they begin with a chill, run their course with a violent feeling of heat, warm sweating, flushed face, headache, as also delirium and sopor (Zimmermann) and full tense pulse, and in most cases end favorably, but sometimes lead suddenly to collapse, and then get into the state which is peculiar to the gangrenous disease.

Many epidemics have been marked with this "inflammatory" character. Griesinger describes such cases as occurring in Egypt. In the Swiss epidemic, described by Zimmermann, as well as in that at Mayence (Pauli) this form seems to have

occurred frequently; while in the epidemics at Herford (Mursinna) and Nimeguen (Degner), and also in the war of 1870, they had less of this character.

In thirty-two cases in which the temperature was taken several times every day at the Leipzig hospital the following results were obtained. It should be mentioned that these observations were made only from the fourth or fifth day of the disease.

Of twelve light cases there was no fever in six, a short catarrhal fever in one, and subfebrile temperatures in five (about 100.4° F.).

Of fourteen moderately severe cases, long-continued remittent fever occurred in three, short high fever in two, subnormal temperature in two, no fever in seven.

Of six fatal cases there was moderate fever in one, no fever in three, subnormal temperature in two. Almost all these cases showed a considerable *increase of temperature, attributable to the approach of death*, a few hours before death occurred.

The pulse varies but little from the normal, except for the changes occurring during collapse. Warm sweating occurs often, cold sweating still oftener. The thirst is almost always very considerable.

Of greater importance is the influence of dysentery on the *general strength.* Even in light cases, if the disease lasts some time, poverty of blood and wasting occur, and convalescence is slow. In all severe cases, however, the constitutional state supplies the best measure for the severity of the affection in the intestine, and any increase of the disease is marked by indications of the collapse which is characteristic of gangrenous dysentery. In this state the patient always gives the impression of violent poisoning (infection), and the excessive weakness of the heart leads to a condition very like the collapse of cholera. At the beginning of this state the patient lies quite dull and exhausted, in a distressed state of mind. The face is drawn with pain, the skin of livid color, dry and stiff, all parts noticeably wasted, the pulse small and frequent, the tongue generally smooth and red, the appetite entirely gone, frequent singultus. If the collapse increases, the pulse becomes threadlike and disappears, the singultus becomes continuous, the skin lacks its natural elasticity and is covered with cold sweat, the extremities are cool and livid, the nose pinched, the eyes sunken, the voice hoarse; here and there partial spasms of muscles occur, the paralyzed anus does not retain the discharges, and the patient consequently is surrounded with a putrid odor.

When these symptoms have become fully established death generally occurs within a short time. Sometimes, however, this

state lasts many days and undergoes many fluctuations before the patient is released from his tortures.

Chronic dysentery causes constitutional disturbance of a different kind. It may end, namely, in what might be called tabes dysenterica, or dysenteric consumption; a true state of inanition, with excessive anæmia, wasting, and weakness. Now and then true spinal paralyses seem to arise in connection with this kind of consumption; and in other organs also, especially in the lungs and kidneys, other consecutive diseases are set up, which completely break up the whole system.

COMPLICATIONS.

Dysentery may follow any disease. It chooses weakly and sickly persons by preference.

Typhoid fever may arise in the course of dysentery, or dysentery in the course of typhoid.

In hospitals it attacks patients affected with tuberculous and other chronic diseases. All the affections mentioned on pp. 546 and 547 may occur as complications of dysentery either under influences not yet well understood, or as direct results of dysentery. These affections can, however, not be considered as regular or frequent complications of dysentery.

Only the conditions now to be mentioned can be so considered. In the tropics at least they are essential complications.

1. *Hepatic Dysentery.*—In this there appears simultaneously with, or even before the intestinal disease, an inflammatory affection of the liver which develops gradually, and finally leads to the formation of an abscess. According to Annesley a combination of these two diseases has generally a chronic course. The first symptoms of inflammation of the liver are generally obscure: dull pains in the epigastrium and right hypochondrium, radiating out towards the shoulder, præcordial distress, a trembling tongue with a yellowish coat, want of appetite, vomiting. After these symptoms have lasted a while, the affection of the intestine comes on. Then the subjective symptoms of the liver disease often disappear. All the patient's attention is turned to the dysentery. If there is improvement in the dysentery, the above

mentioned symptoms reappear, and such an alteration may occur several times, until the physician is surprised by the sudden death of the patient, and the autopsy shows an extensive abscess in the liver, besides the disease in the bowel.

The close connection between these two affections is not yet clearly explained. Annesley's hypothesis is without positive proof. At any rate, this affection is not to be confounded with the hepatic abscesses of *embolic* origin, which also occur here, and sometimes follow chronic dysentery.

2. *Scorbutic Dysentery.*—This affection is observed in the tropics, but also in our climate, especially in camps, hospitals, prisons, and other over-filled spaces where the food is insufficient. The exudation into the intestine is then mainly hemorrhagic, the stools consist of pure blood, and often vomiting occurs. The characteristic affection of the mouth occurs, and numerous petechiæ and blood-blisters appear, which finally become ulcers. Single cases of this kind are observed in most of the severe epidemics.

3. A *complication* with a *rheumatic articular affection* is observed now and then. Stoll reports several such cases. I myself once saw a very painful affection of the ankle alternate with a moderately severe dysentery.

Secondarily, as a complication of other diseases, dysentery appears chiefly with a few constitutional diseases :—typhus and typhoid fevers, variola, measles, yellow fever. The symptoms of dysentery mingle with those of the original disease, and may even sometimes disguise them. Often, however, they do not make their appearance in a characteristic manner.

DIAGNOSIS.

The diagnosis rests on the condition of the stools. All other symptoms, even the tenesmus, may be wanting, at least at the beginning of the disease. For this reason a careful and daily examination of the discharges of the patient is absolutely necessary to a proper estimation of the disease. The presence of colics and tenesmus should always lead us immediately to such examination. If the discharges are altered in the manner

described, there can hardly be a doubt with regard to the presence of the disease. In the mildest form, where the stools are only slimy or shreddy, there may indeed be only catarrh of the large intestine, and it is, properly speaking, always a matter of opinion at what point we should consider catarrh as ceasing, and sporadic dysentery as beginning. It is conventional to call it dysentery when the mucus contains a great deal of blood. In this case it could only be mistaken for proctitis, accompanying hemorrhoidal bleeding, or for an ulcerating growth at the lower part of the large intestine. In both these cases there may be tenesmus, but the blood is not so closely mixed with the mucus, and the bleeding occurs after or before the stool. Moreover, in such doubtful cases an examination of the anus and rectum should be made, though the further progress of the disease, indeed, soon removes all doubt.

If the discharges are of the second kind (the lotio carnea, with its lumps of mucus containing pus and blood) there can be no doubt but that sero-purulent dysentery is present. Such discharges do not occur in any other disease.

It is, however, much harder, especially in the first few days, to decide whether a dysentery is the catarrhal, or the diphtheritic form, about to become gangrenous later. This is by no means always to be recognized from the condition of the stools (see p. 549), and they must, at any rate, often be examined microscopically. The most important means of diagnosis is always the general condition of the system ; the presence of nervous symptoms (præcordial distress, very violent vomiting, singultus), as well as a suggestive depression of the heart and collapse always indicate the presence of the severer form.

The extent of the disease in the intestine is estimated on the one hand by the extent of the tenderness, the objective intestinal symptoms (page 552), and on the other hand by the intensity of all the symptoms, and a certain intimate mingling of the normal and abnormal constituents in the stools (page 550). In chronic dysentery the stools are often not characteristic for a long time, and there is no tenesmus. It is, therefore, necessary to inspect the discharges frequently, and especially to look for the presence of flakes of pus and blood, even when small in

quantity, and for the structure mentioned above as resembling frog's eggs (page 550).

DURATION, RESULT, PROGNOSIS.

In light cases of dysentery (the sero-purulent affection of slight extent) convalescence begins after from eight to thirteen days, and recovery is complete in about three weeks.

Cases of medium severity (the extended sero-purulent affection with diphtheritis at certain places) last from three to four weeks, when they have a favorable course, and for complete recovery, from two to four weeks more are required.

The severe cases (widely extended diphtheritic exudation, gangrene) last an entirely indefinite length of time. They may result in death after a short or very long duration, or recovery may occur after the disease has lasted seven or eight months. Death does not generally take place in the most severe cases during the first week, but on the ninth or tenth day, or at the end of the second week, or at any later time whatever. Only in the tropics do cases seem to occur with excessively rapid course and fatal result within two or three days.[1] It is almost always brought about by exhaustion, inanition, etc., arising from the local affection, less often by perforation of the bowel, peritonitis, etc., and still less often by any other complication.

The mortality in single epidemics is very various. In epidemics occurring in this part of the world it is much smaller than it is in the tropics, where it is especially large among newcomers. There the disease seems to prove fatal to from twenty to thirty per cent. of those attacked (*Macpherson*, on Bengal dysentery, etc. Calcutta, 1850). But the percentage is sometimes still higher, amounting to thirty-six or forty per cent. (Griesinger), and even from sixty to eighty per cent. (Peru). Here it amounts only to from seven to fifteen per cent. on the average, as far as has been made out (*e.g.*, in the epidemics at Würtemburg; *Hauff*, loc. cit.). A much more excessive percentage is, however, reached at times in our epidemics. In Herford, for

[1] Single instances have occurred in our part of the world, as in the village of Viterne, 1734 (*Zimmermann*, loc. cit., p. 357).

example, 1,779 died, more than twenty-five per cent. of those attacked, and five per cent. of the whole population.

The *prognosis*, therefore, depends firstly on the general circumstances under which each case occurs, the character of the epidemic, the climate, etc. The sporadic dysentery of our climate is almost always favorable.

In single cases the prognosis may be made out from the diagnostic symptoms mentioned on pages 556 and 557. If the dysentery proves to be diphtheritic, the case must be regarded gravely, and it is then mainly a question of its extent. The longer a severe case runs on, the more favorable it is for the patient; the longer a light case, the less favorable. Gangrenous condition of the stools, very violent bleeding, nervous symptoms, and indications of collapse, are the most unfavorable signs; on the other hand, slight loss of strength, retention of a certain amount of appetite, short duration of the tenesmus, are the most favorable. Old persons, infants, sickly individuals, and drinkers are always especially in danger.

Secondary dysentery is always to be regarded as a very unfavorable complication with another disease.

TREATMENT.

Prophylaxis.

We do not know what the miasma of dysentery is, and are, therefore, not able to render harmless the conditions on which it depends. We know of nothing which protects against its influence. Prophylactic measures must, therefore, be directed first towards limiting the extent of an epidemic which has once arisen, and secondly, towards protecting the individual against the predisposing causes of the infection. To accomplish the first, all the houses, streets, or districts where an epidemic has broken out should be submitted to a careful examination; every source of uncleanliness in corners, courts, etc., should be destroyed; privies, drains, and sewers should be thoroughly disinfected. Houses in which many persons have been attacked with dysentery should best be completely emptied, and left vacant several

weeks. The discharges of the patients should be disinfected with chloride of lime or carbolic acid. All night-stools, instruments, etc., should, for safety's sake, be isolated and disinfected. Crowding together of people in infected places should be avoided altogether, and all business, except what is absolutely necessary, should be given up. Barracks, prisons, etc., ought to be especially watched, and prophylactic disinfection is advisable.[1] In hospitals it is best to place the patients in separate rooms, instead of crowding them together. The same care is necessary with the utensils, etc., as in private practice.

In the tropics it is best to avoid entirely those regions where dysentery is endemic in the dangerous season of the year; especially is this important as regards armies.[2]

In order to avoid the individual predisposition as much as possible, great care of the bowels should be taken. In the etiological part of this article we saw that irregularities of digestion, especially constipation, were very injurious. Articles of food which cause flatus and constipation are to be avoided (especially those containing a large amount of starch, as potatoes). Persons who are constipated by milk must avoid that also. Rather a low diet is recommended; at the same time a moderate use of slightly laxative food, especially ripe fruits (grapes) and stewed fruits may be allowed. All things which irritate the mucous membrane of the bowel—of course half-ripe fruits, salads abounding in cellulose, strong spices, greasy, fried food, etc.—are strictly to be avoided. The older physicians disapprove of the use of strong wines. Each one should carefully avoid the things which "do not suit him," when dysentery is epidemic. If indigestion occurs, a mild cathartic, to empty the bowel as quickly as possible, may be considered the best prophylactic (see p. 530). As a precaution against chilling the body or the legs, flannel underclothing, waistbands, and frequent changing of the stockings are recommended for those still in health.

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[1] Mursinna gives a description of very perfect sanitary regulations with "inspection from house to house," including disinfection, etc., in the Herford epidemic in 1779.

[2] In lower Egypt they protect themselves from dysentery by a stay in the desert or a sea voyage. Recoveries from dysentery are often accomplished by these means alone (*Griesinger*).

New-comers in tropical regions should try to change their habits gradually to those of the place, under the guidance of a physician, and carefully avoid every error of diet.

Special Treatment.

Regime.—The patient should stay in bed, first, in order to preserve an even temperature; and secondly, because movements of the voluntary muscles excite peristaltic movements, which, however, take place spasmodically and without producing any good result. The room should be rather warm, 59° to 61° F.; it should be aired thoroughly every day. Chilling of the patient should be carefully avoided. The most scrupulous cleanliness of bed and linen is necessary. The latter should be changed with great care. The anal region should be frequently washed; the bed should be firm and supplied with the necessary protectors; an extra bed is very desirable; a water-cushion is also to be recommended. If possible the patient should have his own bedpan or night-stool, enema syringe, etc. All vessels, as well as the discharges (at any rate, in cases of epidemic dysentery) should be disinfected several times a day. The air of the sick-room should in malignant cases be disinfected with chloride of lime or fuming vinegar.

The diet must be regulated mainly according to the state of the stomach and upper part of the intestine. There are cases in which the digestive power of the upper part of the bowel is pretty well retained, and where even the appetite is not very much diminished; in such cases, in view of the active wasting of the body from loss of blood or fluids, and by pain, mild articles of food may be safely given even during the disease: milk (condensed), strong soups, egg with water, the yolks of eggs, pure beef juice (uncooked). All hard substances which form a large quantity of fæces (meat, vegetables, potatoes, etc.) must be strictly avoided. Drinks should be lukewarm, because cold fluids always bring on painful contractions in the transverse colon. Spirituous drinks should be entirely avoided. In cases with want of appetite, vomiting, etc., a prescribed diet must be rigidly adhered to. The best way is to drink barley-water, thin

oatmeal gruel, Sydenham's decoction or almond emulsion, lukewarm, and to this may be added with advantage a small amount of bitartrate of potash (thirty grains to a pint of fluid) as a cooling and gently aperient medicine (according to the advice of Zimmermann). During convalescence the diet is to be most carefully watched. When the patient begins on solid food, he should take only the white meat of fowls, delicate fish, and very light puddings, and for a long time all those articles of food should be avoided which were mentioned as unfavorable when treating of the prophylaxis. The dietetic treatment alone is sufficient in many light cases of dysentery, where the affection is limited to the rectum and the neighboring parts of the sigmoid flexure, and is of sero-purulent nature. In addition to nursing the patient, it is only necessary to seek to alleviate the more severe subjective discomforts. The colic pains may be relieved by fomentations, or, still better, by warm poultices of linseed meal, coarse oatmeal, etc., and for the tenesmus, which in such cases is moderate, repeated applications of mild and slightly binding enemas (especially of starch enemas), to which a few drops of laudanum have been added. Frequently the tenesmus ceases after the first enema, and the next stools become normal.

In cases of moderately severe dysentery, however, medical treatment is necessary, the object of which should be to shorten the inflammatory process, and especially to prevent the development of exudative inflammation if the form is catarrhal, for we are, alas! not in a condition to attack diphtheritic dysentery with any success.

Genuine antiphlogistic treatment can be applied to the inflammatory process we are now considering only to a limited extent. Venesection, which was formerly much used (by Sydenham, Broussais, and others), is now very properly abandoned. Local bloodletting on the abdomen, over the affected portions of the intestine, can hardly have any influence on the vessels of the intestine concerned in the inflammation, because the vessels of the two parts communicate too little with each other; this treatment should therefore be limited to cases with excessive pain and symptoms of peritonitis; it is better to take the blood at the anus; here vessels are emptied which are directly con-

nected with those of the diseased mucous membrane. In the beginning of the attack, therefore, from ten to twenty leeches can be applied around the anus (according to Pruner this is often practised in Egypt with good effect).

The use of cold, in the form of continual ice-compresses on the abdomen, and ice-cold enemas, are not well borne by the majority of patients, because the colic pains, in the beginning at least, are generally increased thereby; only where the cooling process can be continued uninterruptedly can this treatment be successful,[1] for otherwise the intestine will be only injuriously stimulated by being made alternately cool and warm.

In a children's hospital at Vienna I saw light cases of catarrhal dysentery successfully treated with repeated enemas of ice-water.

Another indication is to keep the inflamed part completely at rest; this is doubly desirable in case of the intestine, because the venous hyperæmia of the mucous and submucous coats is increased by the spasmodic contractions of the muscular coat, and in this way the inflammatory stagnation of blood, and the extravasation of white and red blood-corpuscles, will only be encouraged. Unfortunately it is not possible to secure perfect rest of the bowels in severer cases. The attempts to accomplish this, with continued application of cold, have hitherto not been satisfactory, and drugs do not accomplish this end. Especially is it impossible with opium or morphine to keep the bowels at rest all the time. The colic and tenesmus are indeed moderated for a while, but they return after a time, even in spite of larger doses, and are then more violent than before. Beside this, the state of stupefaction and heat into which the patient is brought by the use of opium is decidedly unfavorable in dysentery. I would therefore, in common with the majority of writers of this century and the preceding one, not give my approval of the methodical use of opium in dysentery, and would only use this drug temporarily and as a palliative remedy.

[1] According to the lately published investigations of *Horvath* (Centralblatt, 1873, 38-41) cooling of the intestine below 66.2° F. completely prevents peristaltic motions. The question indeed arises whether an even and continuous cooling of this kind could be obtained by external applications, however constantly kept up.

On the contrary, an experience of several centuries in tropical countries, as well as in epidemics of moderate zones (Zimmermann, Mursinna, Pauli, Rollo, Annesley, Trousseau, and many others), has taught us that dysentery runs a most favorable course, and is soonest recovered from, not with a binding treatment but with the use of laxative measures, *i.e.*, with the use of emetics in the beginning of the disease and with mild cathartics during its course. The ancients believed that the good effect of this treatment consisted in its removing the acridity which gave rise to the dysentery: with our present knowledge we must give up this idea. We cannot, however, replace it by any other satisfactory explanation, and must rest contented with the fact as it is. It is doubtless of great importance to remove any harmful ingesta and old fecal masses;[1] but the whole value of the treatment does not probably consist in this.

The emetic should be given at the beginning of the dysentery, especially where nausea and the so-called status gastricus exist. The best medicine is the long-renowned ipecac, in doses of from fifteen to thirty grains until thorough vomiting takes place. Formerly tartar emetic was used, but it is less to be recommended. In the tropics it often seems as if a timely emetic cut off the further development of dysentery. In the last war, ipecac was used by some of the English physicians with good result in France.

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[1] In describing the etiology we mentioned that collections of fæces had a great influence as a proximate cause, and more especially were injurious after the disease had already begun. This fact supplies an important indication for the use of cathartics, but cathartics also operate favorably where such collections of fæces cannot be certainly proved to exist. Almost always the stools become larger, and therefore occur more seldom; the pain and continual distress of the tenesmus is diminished. Ballonius (Consult. Med. 23. C. 2.) has already said: "Quod in dysenteria excretio parva et frequens, faciendum, ut sit contra rara et magna." One can easily make the experiment upon himself, and will find, if he takes a mild laxative for a summer colic, that the peristaltic movements do not cease, but soon become painless; and that the desire for stool which precedes the discharge also occurs entirely without pain. I cannot give an explanation for this. It is possible that the contractions, which before were spasmodic, violent, and limited, are, by the laxative, made extended and regular; this would have a favorable effect on the distribution of blood in the mucous membrane, for the movement of the blood in the walls of the intestines is favored by the alternate regular contraction and relaxation of the muscular coat, while continued and spasmodic contraction interferes seriously with the return of blood through the veins.

As cathartics, the milder medicines should be used mainly, and the drastics carefully avoided. Above all, castor-oil, to which of late years the preference has been given, and which operates mildly and surely, is to be recommended. Various other medicines, however, have the same favorable effect, especially tamarinds (which were much recommended in former times), rhubarb, ipecac in small doses, also calomel (which may be combined variously with opium in small doses), the salts of tartaric acid (in lukewarm lemonade), and the sulphates (especially recommended by Trousseau and Bretonneau, etc.). With these medicines to choose from, a dose can be arranged to suit the taste of the patient and the medicines can be changed from time to time, since their effect is exactly the same, namely, they arouse the peristaltic motions (Radziejewsky). (Very sensitive patients can take phosphate of soda, which has been lately recommended, and has but little taste.)

It is best to give on the first day of treatment a number of small, or one or two large doses of the medicine, then to discontinue it on the second day, and give only an emulsion of oil, and at evening some opium or morphine. On the third day, artificial catharsis can be begun again, according to the state of the bowels; this process can be repeated on the fifth and seventh days, attention being always paid to the state of the patient.

It is very important to recollect that the good effect of cathartic treatment is to be expected only in fresh cases. In old cases this treatment may be used from time to time, but a lasting effect is not to be expected.

The local treatment of the lower part of the bowel is another important matter; here the inflamed mucous membrane can be directly reached with medicaments, and this treatment would be the most important of all were it not that, in the first place, in case of dysentery of great extent, only a small part of the diseased organ would be reached by the injected fluid (the resistance being increased on account of the contracted state of the bowel); and secondly, the application of the instruments often makes the pain, which the patient already has, quite unbearable.

The following enemas may be used:

1. Soothing and narcotic fluids (linseed tea, starch enemas

with opium). 2. Solutions of cathartics in demulcent vehicles: bitartrate of potash, castor-oil (Annesley). 3. Solutions of drugs which are meant to act directly on the inflammatory process. Among these the astringents are particularly to be mentioned: simaruba, colombo, rhatany, tannin, sulphate of zinc, acetate of lead, alum, and, above all, nitrate of silver in enema (from three-quarters of a grain to four or five in from one and a half to two ounces of fluid).

Further, iodine enemas are recommended (from five to nine grains each of iodine and iodide of potassium to an ounce and a half of distilled water), and lately chlorate of potash (Löbel,[1] a scruple to two ounces of hot water); also, ergotine (Gros:[2] twelve or fifteen grains in enema).

Of these enemas those that relieve pain have of course the greatest value; only the mildest cathartics must be used by enema, and the internal use of them is to be preferred in the majority of cases.

We must not expect too much from the astringent enemas, for in a majority of severe cases much too small a surface is reached. In the dysenteries of 1870 I used the much-renowned nitrate of silver enemas, almost always without any evident good result; on the contrary, the pain was increased. With regard to articles that have been very lately recommended, I have had no experience. In place of narcotic enemas, suppositories, already recommended by Alexander de Tralles, may be used with great advantage in cases where the rectum is very sensitive. (The suppositories may be made with extract of opium, morphine, extract of belladonna, cannabis indica, etc.)

In cases where the dysentery begins in a diphtheritic form, or where it becomes diphtheritic under unfavorable circumstances, all the remedies hitherto mentioned are for the most part unfortunately useless. We have no means of preventing the effect of such an exudation; the final result must depend upon how widely extended and how deep the disease is. In this case, also, the best treatment probably is to give a laxative medicine every now and then, alternating with narcotics. More experience is requisite to

[1] Report of the Rudolph Hospital in Vienna, 1867.

[2] Allg. Wiener Med. Ztg., 1868, N. 25.

decide whether anything whatever is accomplished by the use of carbolic acid lately recommended by Amelung [1] (carbolic acid, fifteen grains; alcohol, fifteen drops; laudanum, from fifteen to thirty drops; mucilage of gum Arabic, syrup of poppies, each six drachms; water, four and a half ounces. A tablespoonful every three hours).

Our efforts must above all be directed towards supporting the rapidly failing strength of the patient, and preventing exhaustion of the heart, which quickly brings on fatal collapse; the patient should, therefore, take as much nourishing food as possible (in the form of strong soups, meat-tea, meat-juice, eggs, wine, etc.), and this should be insisted upon.

Spirituous drinks should not be avoided in these cases, but may be given according to the taste of the patient, by preference warm, in the form of grog, punch, warm beer, wine-soup, etc. When collapse sets in we must resort to restoratives, viz.: the subcutaneous injection of camphorated oil, of anisated solution of ammonia,[2] musk, etc.; for the most part, however, nothing will be gained by them.

The internal administration of the astringents mentioned above (p. 566) has often been recommended in the later stages of dysentery and in chronic dysentery; the vegetable medicines of this kind (tannin, rhatany, colombo) seem to have been used often with advantage. Of the metallic astringents acetate of lead and nitrate of silver are especially famous. In my opinion we should not expect too much from remedies of this class. The improvement of the patient's general condition is of the greatest importance. In addition to very careful nursing we must seek to make his food as nourishing as possible by a carefully selected diet. Frequent warm baths are of use to keep the skin in a healthy condition.

The Neptune's girdle of the hydropathists may be used advantageously by patients who are allowed to rise. In the tropics a change of residence has a wonderful effect in the cure of dysentery. In our part of the world, also, change of air is

[1] Berl. klin. Wochenschrift, Nr. 11, 1873.

[2] Oil of anise, one part; alcohol, twenty-four parts; water of ammonia, five parts. —*German Ph.*

worth trying. To supplement the treatment which has been above recommended, tonics are to be given, viz. : iron (in large doses of an easily digested preparation) and quinine (which was a favorite remedy even with the older physicians in the form of decoction of bark.

The other complications which may occur (perforation, secondary inflammations, etc.) are to be treated according to the usual rules. In cases of dysentery, complicated with disease of the liver, Annesley speaks highly of general and local bloodletting and the administration of the preparations of mercury (calomel in large doses, inunctions of mercurial ointment in the region of the liver). Abscesses of the liver are often, as is known, operated upon with good result. (See hepatic diseases).

Scorbutic dysentery requires, in addition to the usual treatment, fresh vegetable food (lemonades) and an early use fo strengthening measures.

DIPHTHERIA.

OERTEL.

DIPHTHERIA.

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HISTORY.

Diphtheria is one of the oldest epidemic diseases of the human race. Even Homer and Hippocrates advanced views from which Bretonneau first sought to prove that the disease was known, even in those times, under the name of Malum Ægyptiacum, as a disease greatly to be feared. As a preventive against the malady a combination of sulphate of copper with honey was recommended. This remedy has retained its position in the Pharmacopœia for centuries under the name of Unguentum Ægyptiacum.

Besides these notices of the disease, we find that Aretæus (at the close of the first and beginning of the second century after Christ) gives a most characteristic description of the Malum Ægyptiacum, in which he especially emphasizes the fact that the tonsils are covered with "quodam concreto humore albo," which spreads over the tongue and gums. The ulcers which are found on the tonsils, and which are clean, small, superficial, without inflammation, and painless, are benignant; while on the other hand those which are extensive, deep, putrid, and covered with a white, livid, or blackish clot, usually prove to be malignant. In fatal cases the fetor, which comes from the mouth of those affected with the disease, is so loathsome that the patients themselves cannot endure it. Fluids are regurgitated through

the nose, and there is hoarseness and loss of voice. When the disease extends quickly to the air-tubes, it produces death in a short time by suffocation. Children, who have not reached the age of puberty, are most frequently attacked by this disease. This disease originates, according to Aretæus, in Egypt, Syria, and especially in Cœle Syria, whence it derives the name of Malum Ægyptiacum, or Egyptian and Syrian ulcerations. Macrobius describes a similar epidemic disease in Rome in the year 380 A.D.

In later centuries the disease appeared again as an epidemic, first in Holland in 1557, when Forest wrote an account of it; then in the seventeenth and eighteenth centuries it extended over other portions of Europe, especially through Spain, where the affection went under the name of Garotillo,—when it attacked the larynx, and frequently caused death by suffocation,—or Fregar, when it was confined to the cavity of the mouth. It was described by Bonangelinus, Casales, Villa Real, Fontecha, Herrera, also by Vasques and others. In Italy it was described by Carnevale, Scambatti, Nola, Severinus, Ghisi (Lettere mediche, 1749), and others; in France by Chomel (Diss. sur le mal gorge gangréneux, 1749); in Holland by Heredia; in Germany by Schobinger (Diss. de morbo strangulatorio seu maligno faucium carbunculo, 1650); in England by Fothergill, Huxham, Withering, Keetely, Johnstone, W. Grant, etc. In North America Samuel Bard made observations upon it.

In citing these more general descriptions we would call attention to the fact that they are not to be received as exact, as they do not always avoid confounding the disease with other affections, such as scarlatina, etc. The first accurate investigations into the nature of diphtheria were made by Bretonneau, and laid by him, in the form of two treatises, before the French Académie de Médecine in 1821. Bretonneau first called this form of angina diphtheritis,—a name which he gave to the disease because of its essential characteristic, the exudation. According to this writer, an inflammation without exudation is never a diphtheritis, and no inflammation with exudation is diphtheritis, when it does not spread by contagion, and indeed the membranous exudation is the poison itself, which forms the pathological criterion for this

disease. From numerous facts he believed he had proven that contagion occurred only when the diphtheritic secretion, in the form of fluid or dust-like atoms, came in immediate contact with soft mucous membrane, or with the skin deprived of its epithelium. Inoculation, he believed, was the only possible mode of conveying the disease, while the atmosphere, on the other hand, did not act as a medium for spreading the contagion. Finally, croup and diphtheria, in Bretonneau's judgment, are one and the same disease, and the latter is only the highest degree of the former; on the other hand, angina gangrenosa is not related to this affection.

Although Bretonneau at first insisted that diphtheria must be considered as wholly a local disease, he was obliged at a later period to concede that a blood-poisoning is one of its essential characteristics.

Since the time of Bretonneau, diphtheria has broken out repeatedly in epidemic form in France, England, Holland, and Germany, and has given opportunity for numerous investigations. Many excellent works upon the subject have been written by French, English, and German physicians. The views of these writers differ from those of Bretonneau in the fact that they lay greater stress upon the general affection, and include among the secondary affections of diphtheria certain symptoms —especially those arising from abnormal action of the throat muscles—which Ghisi long ago observed in the sickness of his own son (Orillard, Trousseau, Maingault, Steinbömer, Donders, Gull, Weber, etc.). Long after these clinical observations had been made, a pathologico-anatomical basis was first established for the diphtheritic process, through the investigations of Virchow, who directed attention especially to the occurrence, in diphtheritic inflammation, of an exudation into the substance of the mucous membrane, followed by mortification of this membrane from cessation in the supply of nourishment; he also distinguished this type of inflammation from the croupous, in which the exudation lies upon the surface of the mucous membrane.

In opposition to the opinions, based upon Virchow's theory, that diphtheria and croup are entirely heterogeneous processes,

Wagner endeavored to prove that both were one and the same disease; that they only differed in the fact that the one was confined to the throat while the other involved the air-passages, and that the formation of the false membrane depended, not upon the throwing out of a fibrinous exudation over the surface, but upon a peculiar metamorphosis of the epithelium, which he described as a fibrinous degeneration of these cells. Buhl taught that diphtheria was a general infectious disease, entirely independent of any previously existing local disease. He also held that the chief characteristic of the disease consisted in the nuclear or cytoid growth of the submucous connective tissue, a process which leads to the death of these tissues through compression of the blood-vessels. The disease in the throat and air-passages would be, according to this view, not an originally localized affection, but only the indication of a general infection, which manifests itself by preference upon the tonsils, in the pharynx, larynx, etc., as scarlatina does upon the skin.

The discussion concerning the nature of diphtheria assumed a new phase when the discovery was made, by Hueter and myself simultaneously, that the diphtheritic membranes, the subjacent diseased parts, and even the blood, contained in great numbers vegetable organisms, or bacteria, to which I gave the name of micrococci. Pathological experiments were then at once undertaken to solve the disputed question. Trendelenburg and Nassiloff first proved the possibility of infecting animals with diphtheria by inoculation in the trachea and on the cornea; and Nassiloff, in unanimity with Hueter and myself, designated the prolific growth of bacteria, which he discovered in patients sick with diphtheria, and in the inoculated cornea, as the essential elements of diphtheritic contagion. I believe that I have furnished, by a series of experiments, the proof that diphtheria begins as a local disease, and develops afterwards into a general one; and that, moreover, the general infection is kept up by the local one. The disease establishes itself at first in one spot, the focus of infection, and thence radiates, as it were, through the body, until by general blood-poisoning it renders the organism incapable of life. According to the results of the same investigation we must consider croup as a simple form of inflammation,

in which a fibrinous exudation occurs upon the mucous membrane, and which can never pass the bounds of the local process. Finally, an inflammation of the mucous membrane, with fibrinous exudation—or croup—can be induced by diphtheria, as well as by other influences in nature, such as atmospheric conditions, physical and chemical causes of irritation, etc.

The especial significance of vegetable parasites in diphtheria and diphtheritic contagion was still farther insisted upon by Recklinghausen, Waldeyer, Klebs, Eberth, Heiberg, and others, who also pointed to the partial dependence of the pathological changes on the growth of micrococci. Virchow, too, has quite recently called attention to the parasitic nature of the diphtheritic masses found by him in the kidneys and endocardial deposits of puerperal women. I shall take occasion to speak again, farther on, of the various works of these authors, as well as of other works relating to the same subject, and will endeavor to estimate the influence they have exerted in the development of the theory of diphtheria.

ETIOLOGY.

Diphtheria makes its appearance under two different series of symptoms—as a *local* and as a *general disease*—and is in the greater number of cases followed by a third series of disturbances, which have been classed as secondary processes, or *sequelæ* of the disease. The description of diphtheria comprehends these three forms of disease, although they do not always manifest themselves in each individual case.

The *local disease* makes its appearance as an inflammatory process upon certain mucous membranes and denuded parts of the skin which are exposed to the air, and leads to the formation upon them of a grayish-white, false-membranous deposit. It occurs especially on the mucous membrane of the mouth and pharynx, of the nose, the larynx, and air-passages lower down, or on the conjunctivæ. More rarely does the disease localize itself on the mucous membranes of the vagina and rectum, on the points of transition from the skin to mucous membrane, as for instance at the corners of the mouth, on the labia, the pre-

puce, the anus, or the inner surface of the puerperal uterus; while a primary diphtheria of the mucous membranes of the stomach and bowels is much rarer than a secondary affection due to an extension of diphtheria from the mouth and pharynx. Excoriated parts of the skin, however, especially those which are the seat of an intertrigo or eczema, parts denuded by vesicating plasters, leech-bites, as well as wounds and ulcers of various kinds, may form the seat of the local disease or complicate the throat affection.

The *general affection* has the character of an infectious disease, and holds a position somewhere between simple excitement of the circulatory system and the severest forms of typhoid fever and pyæmic poisoning.

The *sequelæ*, which follow the healing of the local process and disappearance of febrile symptoms, are, for the most part, disturbances of the muscular system, which may vary from a paralysis of single muscles to a complete ataxia; on the other hand, in a few cases extreme disease of the kidneys, with dropsy and changes in the formation of blood, and lymphatic growths, have been noticed.

The first task in an etiological study is to explain the diseased process itself, and the question at once arises in what relation do the appearances and symptoms stand to one another, and how do they influence each other reciprocally.

The relations of the local and general disease admit of the possibility of two explanations, which are contradictory to each other, and thus allow two distinct theories of the disease according to the solution of the question, Which causes the other?—the secondary disturbances being always considered as immediately dependent upon the disease which has preceded them. The question to decide, therefore, is whether diphtheria is at first a general disease and poisoning of the blood, and the affections of the mucous membrane are merely secondary localizations, or, whether it begins by infection, as a local disease, and at an indefinite time becomes general.

In order to support the *first hypothesis*, the agreement of a number of its essential characteristics with those of certain infectious diseases has been emphasized; so also the epidemic occur-

rence of the disease, and the marked susceptibility of children to it during an epidemic; further, the great disproportion, noticeable oftentimes even at the very beginning of the disease, between the general symptoms and the apparently trifling local changes, but especially the multiplicity of the localizations as well from a clinical as from a pathologico-anatomical point of view. No little weight has been given to this theory by the fact that the effort to conquer the disease by destroying the diphtheritic product on the mucous membranes by means of thorough cauterizations has been for the most part without result.

We shall not question the correctness of this mode of reasoning, except as regards the last argument, concerning which more will be said further on; but the only proof which it affords is to the effect that diphtheria is a general infectious disease. Still, how the infection takes place, whether through immediate entrance of the infecting agent into the blood, or by the clinging of the same to the surface of the mucous membrane and other parts similarly exposed, and so causing the primary affection of these parts, these are points which are not determined by this manner of reasoning, and still less does it explain the predilection with which the general disease is said to localize itself secondarily upon the mucous membranes of the throat, nose, and larynx.

In favor of the *second hypothesis* it has been stated that the peculiar manifestations of diphtheria occur earliest and most constantly on those portions of mucous membrane over which the air in respiration must sweep, and which most easily come in contact with an infecting agent conveyed by articles used in eating or drinking, or in some other way. With this view is associated the supposition that the germ of disease remains fixed upon the mucous membrane with which it at first comes in contact, and at this place of reception produces also the first pathological changes. It might then be determined with what degree of severity the system generally is attacked, partly by the amount, and partly by the character of the infecting matter, which passes into the blood either from a diseased mucous membrane or from some other part of the body.

Still, from clinical observations and post-mortem examina-

tions it will be possible to obtain only a limited number of facts adapted to the solution of so important a question, since the duty to cure the disease restricts the physician in his opportunities for observation, and the examination of the cadaver allows one only to study a process already completed, and not its inception or further course. Hence the only certain method of definitely determining this question seemed to me to be that of *pathological experimentation*, and I sought therefore by the infection of animals to exhibit clearly the relation existing between the general disease and the secondary localization in the air-passages. If it is true that diphtheria is a general infectious disease, which secondarily makes its first local appearance upon the mucous membrane of the throat and the air-passages, just as other infectious diseases produce their chief pathological changes always in certain organs, so, when diphtheria is induced in an animal by the introduction of diphtheritic poison, must the disease, of necessity, always localize itself secondarily upon the mucous membrane of the throat, larynx, and the air-tubes. The possibility of such an experiment, and the correctness of its premises, are proven by the attempts at inoculation with the poison of glanders,—attempts which were made upon horses, and which showed that the disease always appeared locally upon the nasal mucous membrane, notwithstanding the fact that the contagious principle contained in the nasal mucus had been introduced beneath the skin of the animal.

Now, according to these experiments which I made, *diphtheria fixes itself at the point of inoculation*—the centre of infection, if we may so call the part first attacked—*and radiates from that place throughout the whole body.* The results here described are therefore in direct opposition to the view which maintains that this affection—the poison of which has been taken into the system in some way or other, either by the lungs, or by the stomach or intestines, without causing any appreciable local destruction of tissue—penetrates the whole organism as a general infectious disease, and finally, advancing centripetally to a certain part, there localizes itself. Whenever the diphtheritic infecting agent finds a foothold upon the body, it always excites a local affection in the place where it attaches itself, and it will

depend upon the anatomical relations of the affected part, the facility with which the tissues may be penetrated by the poison, and their power of absorption, how soon this contagion will extend its domain, how soon the sickening of the whole organism, the general disease of infection will develop from the local infection.

Diphtheria occurs sporadically as well as epidemically, and may, in certain localities especially favorable to it, become an endemic disease. It develops spontaneously, its origin being a miasm, and is induced by contact with objects and persons infected with diphtheria. Diphtheria is therefore to be considered *a miasmatic contagious disease.*

A spontaneous outbreak of the disease may frequently be observed, especially in cities, where it has already appeared epidemically, and it is then to be explained only by the theory that the disease has been produced by the action of some miasm, some noxious agent, at certain times widespread, but the nature of which is not yet known. Diphtheria develops very rapidly under the influence of poisonous miasms,—during the prevalence of hospital gangrene, putrid fevers, and bad epidemics of typhus fever; and under these circumstances it not infrequently reaches its highest point of virulence and its widest extent. On the other hand, climatic influences, changes of the weather, the nature of the soil, and social relations, have but little weight in determining the formation and extension of the diphtheritic miasm.

As regards *climate*, the history of diphtheria epidemics shows that the disease is confined to no special climate, and occurs not only in the southern and northern countries of Europe, but over the whole surface of the earth, still with a remarkable falling off in frequency from the higher degrees of latitude toward the tropics; so that the temperate zone, and that part of the frigid zone immediately bordering on the temperate, are most visited by diphtheria.

The *nature of the soil* also does not exert that influence in the production and propagation of the disease which has been ascribed to it by various persons. According to the generally accepted idea, damp lowlands, bogs, and marshy regions with poor drainage, the country near stagnant bodies of water, half-dried river-beds and places where, in a word, the poisonous decomposition of organic matter is prevalent, all these favor diphtheria; while on high, dry lands the disease as a rule appears somewhat more rarely, and does not extend so widely. Still,

although at times the influence of such local conditions appears to be especially marked, yet statistics show that diphtheria, after all, is not to be wholly gotten rid of by any peculiarity in the local conditions, nor can these peculiarities even exert a material influence in diminishing the intensity of the epidemic. In England the disease passed through the marshy lands of Essex and Yorkshire, crossed the fertile regions of Devon, and those of Cornwall, which are but little cultivated, and over which the sea-breeze sweeps freely, appeared on the banks of the Thames, reached the heights of North Wales, and disappeared in the Cornish mines. In Holstein the disease has been observed with almost the same frequency (Bartels) in the swamp districts and on the dry highlands—on moist clay and the dryest sand. Even the sea-coast exerts no influence for or against it; for while the regions near the coast of the North Sea have been visited by comparatively few cases of diphtheria, in certain parts of the Baltic coast the number has varied very greatly; for instance, in Kiel and its neighborhood there were very many cases, while in other places there were almost none at all. It is more than doubtful whether the geological position of the place influences the epidemic appearance of diphtheria, or whether the chalk-formation proves more favorable to its development than the marl-formation (Maier.)

As regards the *effect of the weather and the seasons*, up to the present time no one has advanced positive or definite opinions. The disease is not affected by either heat or cold, drought or rain. In England several severe epidemics appeared in the early part of the year, and lasted through the whole summer, being uninfluenced by the temperature, and neither the heat of the dog-days, nor severe frosts, nor an agreeable and moderate temperature affected the prevalence of the disease. Trousseau ascertained, from the tables of mortality in different villages in which this disease prevailed, that its declension in certain places occurred at the beginning of winter, in others during the rainy season and in spring, and in others still, during the dog-days. Epidemics of diphtheria have been observed in Germany not only at all times of the year, but also under the most varying atmospheric conditions.

The statistics of Wibmer[1] show a greater prevalence of the disease during the winter, especially from September to December, which period had afforded an especially high mortality in diphtheria, in comparison with the months from April to August, when the mortality from diphtheria was at its minimum. Also, in the epidemic which prevailed in Berlin from August, 1868, to April, 1869, according to Albu's report, the epidemic reached its height in the very rainy month of November. How far, then, these more recent statistics indicate a positive influence of the seasons upon diphtheria epidemics, or whether still other unknown conditions have exerted their influence as well, are questions to be decided through further observations. The same is true also in regard to the influence exerted by the weather upon the character of epidemics, inasmuch as it is generally believed that, according to observations, the larynx and air-tubes are far more frequently affected

[1] *Wibmer.* Statistischer Bericht über die Münchener Epidemien vom Jahre 1864–1869.

with the disease in the cold and dampness of winter than in the warm summer months.

The *social relations*, finally,—in so far as we consider under that name the different conditions of domestic life, the industrial pursuits, as well as the resulting individual physical state of health, and any other cognate influences which are likely to prejudice the health in general,—seem, in contradistinction to what has been previously said, to exert a more definite influence in occasioning an outbreak of diphtheria and favoring its spread. The development of a zymotic disease is particularly favored by poverty and uncleanliness, and when diphtheria first invades the hovels of the poor, where the air is impregnated with animal emanations, where men and animals are crowded together under the same roof, and dung-heaps, privies, and other sources of animal putrefaction fill the air with their effluvia, it only follows the general law. Living in damp dwellings and in rooms on a level with the earth's surface, seems to exert upon children a similar evil influence, and these hurtful conditions, as well as the fact that the disease is wont to break out in rooms, factories, schools, barracks, etc., which are insufficient in size and overcrowded with human beings, have been proven, especially in the epidemics in England and France. But even families which live under more favorable circumstances are not spared. Robust children who enjoy the best of care and nourishment are seized and carried off by the disease, although the number of such cases does not reach that attained in other classes, in which poverty and uncleanliness favor the spreading of the pestilence. Finally, the rich and cultivated offer a large contingent of victims to the disease: persons who are either anæmic or weakened by previous sickness, or through high living suffer from plethora, or are of lymphatic temperament, and such as have lost their health through dissipated habits of life.

Diphtheria, when it has once gained a foothold, becomes widely diffused by contagion. The fact of *contagiousness* is established, as well by actual cases which occur, as by experiment.

Although it is generally admitted that when several members of a family or community are successively attacked, the disease may have developed as well through the influence of the prevailing miasm as by contact with objects infected with diphtheria, yet a series of observations has been made which shows that the disease evidently broke out, because the persons seized lived in the same house with the patients, and came in direct contact with diphtheritic matter.

Wertheimber gives a case of a person sick with diphtheria, who, living at the time of attack away from home, returned to his family, in which until then no

disease of that nature had occurred; several days after his arrival another member of the same family was attacked with the disease. Four members of a family under my observation fell sick a few days after the return of a son from college; he was already sick with diphtheria at the time, and communicated the disease by kissing. Infection by contact with detached masses of exudation and mucus takes place chiefly in this way: the patient coughs what has collected in his throat into the mouth or nose of the examining physician; or, as more commonly occurs, it is brought about by inflating the lungs, or clearing the tracheotomy tube by suction in cases of tracheotomy for asphyxia. In this way, Otto Weber, Seehusen, Valleux, Blache, Gillite, fell sacrifices to their professional devotion. Dr. Wiessbauer, in Munich, lost his child, which had a short time previous to its death unfortunately gotten hold of a canula and put it in its mouth, the canula having just been removed from a patient sick with diphtheria.

In opposition to these cases we must mention the experiments of Trousseau, who vainly endeavored to infect himself and two of his pupils with diphtheritic matter; also the cases which Kunze and myself had the opportunity of observing: in one of these cases noticed by Kunze, the mother of a child which had been operated on, cleansed the tracheotomy tube several days in succession by blowing through it with her mouth, and in the other case, my own, the aunt of a child wearing the tube did the same for her niece; in neither of these cases did infection occur. The explanation of these cases may be possibly given in the insusceptibility of the mucous membrane of these persons to diphtheritic contagion.

As regards direct inoculation of diphtheritic matter, it should be mentioned that attempts have been made by Trendelenburg and myself on rabbits in the trachea itself, by Hueter, Tommasi, and myself on the muscles, by Nassiloff and Ebert in the cornea, with positive success; in fact, in Trendelenburg's and my experiments, not only did a diphtheritic membrane form in the trachea, but there was also an infection of the blood, and acute disease of the kidneys, followed by death on the second or third day. In the experiments by Tommasi, Hueter, and myself, the edges of the wounds were covered with a diphtheritic layer, a hemorrhagic inflammation in the muscles was induced, and the general disease killed the animals usually in thirty hours. Nassiloff and Eberth produced diphtheritic keratitis, which likewise caused death on the fourth or fifth day.

The virulence of the contagion is in proportion to the severity of the case from which it comes; the more it is allowed to collect in the room where the patient lies, that is, the less care is bestowed upon ventilation, removal of the expectoration, and cleanliness in general, the more active does it become. But the intensity of a diphtheritic process in a special case does not enable us beforehand to judge of the severity of the disease in one infected from the same case. Exceptionally, infection from one of the mildest forms may lead to a fatal result. The expla-

nation of this circumstance is to be sought for in the greater susceptibility of the infected mucous membrane for the diphtheritic contagion, in the age of the patient, and in other predisposing causes.

The contagion of diphtheria may be carried through the air, or by solid matters to which it has attached itself. It is therefore diffused by the exhalations of the patient, by the air surrounding him, as well as by contact of various objects with the products of disease. As the susceptibility on the part of the individual exposed varies greatly, and is often exceedingly slight, so the diffusion of the contagion is restricted in activity in comparison with the contagion of other epidemic diseases, such as scarlatina, measles, and small-pox. While these exanthematous diseases may spread extensively in a short time, even over large inhabited districts, the epidemics of diphtheria are characterized by the slow extension of the disease, which may often remain confined to a single sleeping apartment, to one floor, or one house. Again, the diphtheritic contagion shows itself in the tenacity with which it clings to certain places, rooms, and houses, and in the fact that it can occasion sporadic cases in those places after the lapse of months.

The diphtheritic contagion seems to find the *most favorable ground* for its development *among children*, that is, up to the tenth year of life. While the disease attains the greatest mortality in the second, third, and fourth years, it attacks children under a year old comparatively seldom, and in the first half year the infant organism seems to be not at all susceptible to the disease. *Adults* in general acquire the disease easily, but it is not commonly so severe as is wont to be the case with children.

The *sexes*, in the first four years of life, seem equally susceptible. Whether it is true, as Albu states he has observed in several epidemics, that the affection occurs more frequently in boys than in girls, after the fourth year, or whether this observation is based on accident, must be determined by further statistical evidence.

Finally, the presence of a *catarrhal affection* of the mucous membrane, as one often has opportunity of seeing, seems to predispose to diphtheritic infection; while the fact of having had

and survived the disease does not grant for any considerable length of time that immunity against a second attack which is one of the marked characteristics of measles, scarlatina, and small-pox.

The most important question in this whole chapter of etiology is that concerning *the relation of certain vegetable organisms to diphtheria;* whether their presence is determined by accident and by the existence of a soil favorable to their growth, such as is found in the products of the disease, or whether they stand in a causal relation to the diphtheritic process; and the discussion of these questions involves that relating to the nature and character of the diphtheritic contagion.

The vegetable organisms which have been observed in the diphtheritic membranes of the fauces and air-passages, as well as in other products of the disease, belong to a group which comprises forms of such exceeding minuteness—for they stand upon the very borders of the visible—that as yet we possess only the most unsatisfactory knowledge of their nature and organization. For the most part these forms are classified under the heads of vibrio, bacterium, zoogloea (Cohn). Naegeli has named them schizomycetes, which, morphologically considered, are to be separated from the fungoid growths, and associated rather with the oscillatoria, although their mode of growth is like that of the fungi. In the discussion of this botanical question I shall follow the admirable description of Professor Cohn, especially as his designation of different species agrees perfectly with my own observations, and in this way alone can the necessary clearness on this subject be attained.

Of the vegetable organisms, which Cohn classifies under the name of bacteria, and which he divides into four genera with one or more species, there is one form in particular (the micrococcus) which penetrates the tissues, wherever a diphtheritic disease occurs, but is also accompanied by a second form (bacterium termo) in greater or less numbers. Other forms appear exclusively in the false membranes which form in the mouth and fauces, more rarely in those of the nose and deeper air-passages. The forms of these vegetable parasites are accordingly:

(1.) *Sphærobacteria* (spherical bacteria), *i. e.*, micrococcus.

(2.) *Microbacteria* (rod-like bacteria); bacterium termo; less frequently, and only in the mouth and fauces, bacterium lineola.

(3.) *Spirobacteria* (corkscrew-shaped bacteria); spirillum tenue, spirillum undula.

(4.) *Unclassified forms:*

(*a.*) Larger cocci with sprouting cells.

(*b.*) Cocci with tube-shaped processes, sprouting conidia, (Cohn.)

(*c.*) Cocci with one or two small waving processes.

For a more exact description of the manner in which these species of bacteria increase and spread in the false membranes and tissues, I must refer to the special pathological anatomy of these parts.

Let us now attempt to explain the relations between the growth of these vegetable organizations and diphtheria, so far as investigations have thrown any light upon them.

The vegetations in the pathological products of diphtheria consist, as already stated, principally of spherical bacteria (the micrococcus), accompanied by a larger or smaller number of bact. term., represented always by the smallest form known, and this occurs so constantly that in every part where a diphtheritic infection has appeared, there the tissues and exudations are filled with these bacteria. They were discovered as far back as 1868, by Buhl, Hueter, and myself (I called them at that time micrococcus [1]) in false membranes, the blood, and the tissues; in like manner they were demonstrated by Von Recklinghausen, Nassiloff, Waldeyer, Klebs,[2] Eberth, Heiberg and others, in the most different organs and tissues. In secondary infection of wounds, tracheotomy incisions, and ulcers, the grayish, skin-like false membranes, as well as the tissues themselves underlying them, are crowded with these organisms.

If the disease increases in intensity, we can always demon-

[1] In the same sense as Cohn uses this term; it is not to be confounded with the micrococcus of Hallier, who applies the term to one of the higher forms of yeast (ferment) fungi. Aerztl. Intell.-Bl. 1868. No. 31.

[2] Compare the interesting attempts at cultivation by Klebs, which give strong evidence in favor of the specific nature of the diphtheritic micrococcus. Arch. f. experim. Path. u. Pharm. I. 1 p. 60.

strate a progressive increase of these organisms in the infected parts, and in the discharge from the fistula established by cutting into the trachea. I have repeatedly demonstrated a rapid and great increase of micrococcus and bact. term., a short time before the formation of a diphtheritic layer on the edges of the wound and the occurrence of consecutive symptoms. These forms, when found in company with other vegetable organisms—although they may have been present in ever so small numbers—give evidence of a far greater vigor in the process of growth, and they soon overgrow and crowd the others aside. Thus, when a thin slimy layer has formed on the tonsils, in cases of catarrhal inflammation of the mouth and fauces, and a diphtheria then sets in, the bacteria and higher forms of fungus, first living and growing in this layer (the leptothrix buccalis, oidium albicans, and cryptococcus) disappear quickly, and their places are supplied by extensive colonies of micrococcus and bacterium termo, the cells of both these varieties being found singly as well as in rows throughout every part of the surface of the mucous membrane. I once observed a marked case of mercurial stomatitis, in which a grayish-white exudation, from two to three mm. in thickness, had formed on the lips, gums, inner surface of the cheeks, the tongue and fauces; this exudation on examination was found to contain almost solely leptothrix buccalis, spirillum tenue, and spirillum undula, together with bacterium termo, and bacterium lineola; as soon, however, as the patient was attacked with diphtheria of the mouth and fauces, which ultimately resulted fatally, I noticed that the vegetable forms above mentioned were destroyed, and instead the micrococcus and bacterium termo appeared in immense numbers.

It is also not a rare thing, in cases which have nearly recovered, and in which the pseudo-membranes have nearly all been thrown off, to find again, in some of the thickened patches that still remain, or in others that have just been formed, a predominance of oidium albicans, cryptococcus, leptothrix buccalis, and other forms of bacteria; while micrococcus, and to a certain extent bacterium termo, will be found to have almost vanished. But before any exudation or destruction of tissue has occurred, even in the very beginning of the disease, these organisms are

already present in delicate, ring-shaped, grayish-white spots, scarcely rising above the level of the mucous membrane; indeed, these spots in the first hours of the disease consist solely of cells of the different epithelial layers and micrococcus growths, the former being penetrated and pushed out by the latter. Pus and fibrinous exudation do not appear on the surface of the mucous membrane until the disease has advanced further, and then the amount depends on the severity of the attack and its reaction on the organism.

The experimental observations made by different writers on this subject, have yielded still other and important results. I have never seen a growth of micrococcus appear on the croupous membranes, which I caused by application of ammonia, although the animals experimented on generally lived much longer than those in which a diphtheritic infection had been produced, and although the fibrinous exudations afforded a soil which varied little, or not at all, in its histological and chemical composition from that induced by diphtheria; I have not even observed it, after the micrococcus commonly present in the mouth had been placed upon the fibrinous exudation while it was in process of formation.

The micrococcus growths which are found in tissues diphtheritically affected, yield very different results from the above when animals are infected with them, and it is of no consequence what part is selected for inoculation, whether the mucous membrane of the air-passages (experiments by Von Trendelenburg and myself), or the cornea (Nassiloff, Eberth), or the muscles (Hueter, Tommasi, and myself). In these cases a rapid increase of the vegetation follows in an extremely short space of time. The point of inoculation forms a centre from which the growth of these organisms radiates through the tissues, and the intensity of the infection is wholly proportionate to the degree in which the tissues are penetrated by these parasites. The mass of micrococci developing in the body of the animal forms the criterion for the severity of the disease and an exact indication of the virulence of the diphtheritic contagion. I have noticed, moreover, in numerous inoculations, that if various bacteria, besides the micrococcus—as, for instance, bacillus, spirillum, and bac-

terium lineola—were present in the matter to be inoculated, only micrococci, and the bacterium termo (in its most minute forms) accompanying them, showed evidence of prolific growth, while all the other forms disappeared altogether. In like manner I have never been able to demonstrate, in often-repeated inoculations with various decomposing tissues (filled with masses of those bacteria which accompany decomposition, as well as with mycelium), that any of these species found their way into the blood, or underwent further development in the tissues bordering on the parts inoculated; but they were to be found, without specially noticeable increase, incapsulated in a larger or smaller abscess, in which the threads of mycelium were to be found, colorless, and with either a complete loss of their protoplasma or a remarkable diminution in the amount.

As regards now the action exerted by micrococci upon the different tissues, in cases of inoculation with diphtheritic material, it has been observed that when inoculated upon the cornea of the rabbit they force their way *en masse* between the layers of the cornea, crowding them asunder, and bring on, ultimately, an intense keratitis, which kills the animal on the fourth or fifth day by secondary general infection (Nassiloff, Eberth).

In the same way, according to my experiments, the bacteria spread over the mucous membrane of the trachea, beset the cellular elements, crowd especially into the young exudation cells, or are taken up by them and gradually cause their dissolution; they fill the blood and lymph-vessels, and bring about in a mechanical way a damming-up of the fluids, and, as a consequence, serous exudation; as they close up the capillary vessels they occasion stagnation in the blood circulation, which induces disturbance of nutrition in the walls of the capillaries, and even rupture of the same. Muscular fibres also, which are covered and filled with colonies of micrococci, degenerate and slough; in like manner in severe cases immense numbers of bacteria appear heaped up in the uriniferous tubules and Malpighian corpuscles of the kidneys, and occasion there parenchymatous inflammation, capillary embolism of the glomeruli of the kidney, with ruptured vessels and formation of epithelial casts in the tubes. In the lymph and blood streams (compare also Hueter)

—where, in long-continued sickness of the animal experimented on, these bacteria also accumulate in masses,—they induce, as excitors of decomposition and disorganization of organic nitrogenous bodies, septicæmia, through the vegetative process they undergo and through their relation to oxygen.

Finally, we must mention also the experiments of Eberth, in which he obtained completely negative results, although the cornea was repeatedly inoculated; in these attempts the pieces of membrane, finely divided, were thrown into Pasteur's fluid, and the liquid was then first passed through a clay filter, or the bacteria were separated from the same by agitation before it was used for inoculation.

Returning now to the original question, there can no longer be a doubt, after the statement of such facts, that these vegetable organisms are not of accidental occurrence, but are inseparable from the diphtheritic process, just as the bacteria of decomposition are necessarily connected with decay and act as a ferment of it. *Without micrococci there can be no diphtheria* (Eberth). We find them even in the very smallest and most superficial plaques, we see them in immense collections in the tissues, we meet with them again in embolism as the cause of metastatic abscess, and the intensity of the toxic infection increases with the number of these organisms.

In what way now bacteria act as regards the *pathogenesis of diphtheria*, whether they consume the life of the blood and tissues, and incite simultaneous decomposition and new combinations of the molecules; whether all the products of assimilation remain shut up in the bacteria themselves, as do the insoluble pigments in pigment bacteria, or are thrown out again like the soluble coloring matters; or whether they form in the blood, as does acetic acid in alcohol, and produce a toxic action like septicin, so that the special action of the fluid or organic substance[1] in which the micrococci vegetate, passes over into them; or

[1] *Bergmann*, Deutsche Zeitschr. f. Chir. I. 4.—*Orth*, Unters. über Erysip. Arch. für exp. Path. u. Pharm. I. 133.—*Dolschenkow* (Path. Inst. von Prof. v. Recklinghausen): Impfung faulender Substanzen auf Kaninchenhornhaut. Centr. Bl. 1873. Nr. 42 und 43.—*Lewitzky*, Einfluss der Bakterien auf die Temperaturerhöhung bei Thieren. Centr Bl. 1873. Nr. 46.

whether, finally, these organisms play the part of a ferment of oxidation or reduction,[1]—all these points, in the present state of scientific knowledge, must be left undetermined (compare Cohn).

Period of Incubation.—The time which elapses between the moment when the diphtheritic contagion comes in contact with the body and that when the development of the poison becomes both subjectively and objectively appreciable, is variously stated; it depends, in the first place, on the quality and quantity of the infecting material itself, and secondly, on the power of resistance, as well as on the structure and texture of the tissues, which permit the penetration and absorption of the diphtheritic matter with varying facility.

The action of this matter on the tissues begins the moment it comes in contact with them; in like manner the reaction of the tissues begins with the earliest irritation; but changes in the diseased tissues, of sufficient extent to be easily recognized, and the appearance of a constitutional disturbance, *i.e.*, fever, are not brought about until these processes have reached a certain degree of intensity and involved a sufficient extent of tissue.

This point of time, which closes the stage of incubation, and from which we date the beginning of the diphtheritic attack, occurs therefore, earlier or later, according to the intensity and amount of the poisonous matter brought in contact with the body. So far as can be judged from observation, the stage of incubation will be shorter during the prevalence of an epidemic, and especially when the type is malignant, than when the disease appears sporadically; it will also be shorter in cases where diphtheritic matter is brought in direct contact with the body, or where there has been long-continued exposure to the disease, than in those cases in which the contagious elements, which are diffused throughout the air, are inhaled for only a short time.

The signs of the diphtheritic process, both local and general, will appear the earlier, the more favorable the local conditions are for the clinging and the development of the infectious agent, and its penetration into the tissues. This will be the case, espe-

[1] *Bollinger*, Zur Pathologie des Milzbrandes. Centr.-Bl. 1872. Nr. 27.

cially where the anatomical structure is no longer normal; where the protective epithelial layer at certain points has been partly or wholly removed, and the open canals, which convey the nutritious fluids of the body and the lymph, render the penetration of bacteria and products of decomposition an easy matter. From twelve to twenty-four hours after artificial inoculation upon the surface of wounds, we can detect a grayish-white discoloration, a dirty grayish layer, and the other signs of infection. The rabbits upon which I experimented by inoculation of the muscles, perished in from thirty to thirty-six hours —in rare cases perhaps at the end of forty-two hours,—from a process which spread to the neighboring tissues and destroyed them in a fearfully rapid manner. In like manner diphtheria develops, after a short stage of incubation, upon excoriated parts of the skin, especially upon those which are the seat of an intertrigo or moist eczema ; so also upon points of transition from the skin to mucous membrane in the corners of the mouth, on the labia, the prepuce, at the anus, and more particularly on surfaces denuded by vesicants, or upon leech-bites, on wounds caused by cutting or tearing, and upon ulcerations of all kinds. Under circumstances like these the stage of incubation hardly lasts longer than forty-eight hours.

The outbreak of the disease upon the mucous membrane of the mouth and fauces, as well as of the remaining air-passages, does not occur until after the lapse of a somewhat longer period ; yet even here the stage of incubation is relatively short in comparison with that of other infectious diseases. According to Roger and Pèter, it varies between two and eight days ; but may, in the opinion of these observers, exceptionally cover a period of from twelve to fourteen days. According to Newmann the stage of incubation is usually very short—from two to three days ; in no one of the cases observed by him did the time extend beyond seven or eight days. The determination of the stage of incubation is most reliable when based upon cases in which exposure to the contagion is known to have occurred at a particular time, and especially in those cases where direct contact of diphtheritic products, as mucus and shreds of exudation, with the mucous membrane of the mouth and fauces, has taken place (Prof. Bartels,

Dr. Kardel). Under such circumstances diphtheritic angina appeared regularly on the third day. The period of incubation has also been stated to be three days by other observers, who were able to determine its exact duration ; and I myself had the opportunity in two cases, in which infection occurred from kissing, to fix the time of the outbreak of the disease at two days after infection. We may therefore state positively, that the latent course of diphtheria occupies from two to five days.

PATHOLOGY.

Passing on now to the description of the disease itself we see that diphtheria, when it occurs epidemically, attacks especially *the mucous membrane of the air-passages*, and from this point, as a centre, *infects the whole organism* and becomes a general disease. As a local affection of the mucous membrane it occasions the manifestations of an inflammation, the nature of which depends partly on the intensity of the local infection, and partly on the reaction of the tissues themselves :—

(*a.*) In the lightest forms we find, in addition to diphtheritic exudations, which, however, may possibly be absent, only the signs of a *catarrhal affection ;*

(*b.*) In other cases the inflammation is so severe as to cause *fibrinous exudation* (croupous form) on the surface of the mucous membrane ;

(*c.*) And the disintegration of the exudation, followed by the processes of decomposition, which in some cases may give rise to *septicæmia ;*

(*d.*) Finally, the inflammation may cause *true gangrene* of the part attacked, though this occurs only in the rarest cases.

The local process, when it occurs in other parts of the body (having been called into action by infection), differs from that already described only in so far as the seat of the disease and the anatomical relations of the part are different. Essentially, however, it is identical with the affection as it appears in the fauces. The symptoms of general infection, which are caused by the local affection, are also the same, and secondary paralysis after diphtheritic infection of a wound may appear in the

same manner as when the air-passages are primarily affected. Since a detailed description of the different lesions consequent on diphtheria would carry us beyond the limits of our subject, we refer the reader for the same to other chapters of this work, to which they more properly belong.

SYMPTOMATOLOGY.

I. *Catarrhal Form.*

Diphtheria of the mouth and fauces begins without symptoms which might give warning to the patient or his friends of the approaching danger, with slight fever or none at all, with a trifling sense of malaise, slight spontaneous pain in the throat, a sensation of dryness, or light pricking pain in swallowing, which in adults is scarcely noticed, and in children cannot be ascertained. The submaxillary and cervical glands swell moderately, and are somewhat tender or painful on gentle pressure.

Only in rare cases does this light form[1] of the disease give rise to more marked symptoms. The fever is then more intense; the temperature of the body stands three or four degrees (Fahr.) higher than the normal, the skin feels dry and hot, the pulse is frequent and full, the face of the patient congested; he complains of heaviness of the head or a sense of stupidity, of a certain lassitude, increased thirst, annoying and painful sensations on swallowing. In many cases certain gastric symptoms show themselves; nausea and even actual vomiting may occur among the first symptoms. Still, after a short time, usually in the course of from twelve to twenty-four hours, these symptoms disappear as quickly as they came on, and the patient feels on the following days so little troubled that he considers professional advice or more careful treatment hardly necessary. The uncertainty of these symptoms, therefore, makes it difficult even for careful parents to appreciate their importance when occurring in children.

When we examine patients early enough, the first thing noticed in the inspection of the mouth and fauces is a vivid red

[1] Compare *Wertheimber* a. a. O. p. 4 and *Senator* a. a. O.

color and moderate swelling of a part of the mucous membrane, while the rest of it appears perfectly normal. Frequently only one tonsil and the adjoining arch of the soft palate, more rarely the soft palate, the uvula and the posterior wall of the pharynx, are attacked by the disease; or a number of these parts may be affected at the same time. The submucous tissue usually swells but little, and the same is true of the glands and the tissues lying still deeper, so that while the enlarged tonsil may project somewhat into the isthmus, its volume is not increased, as is the case in parenchymatous inflammation. When this simple inflammatory process has continued a short time, perhaps only a few hours, small grayish-white or whitish-yellow spots appear. These vary in size from a pin's head to a lentil, and are arranged in a few delicate, ring-like groups, which are either separated from one another by a narrow space or they lie closer together, sometimes even merging the one into the other. In the greater number of the cases belonging in this class the exudation is confined to the one or the other tonsil, and to a few points of the rest of the region of the fauces, without being followed subsequently by the development of false membranes involving a more extended region.

Course of the Disease and its Termination.

Soon after the onset of the disease, after the subjective symptoms, such as may have developed, have subsided, the diphtheritic spots in the mouth and fauces heal rapidly.

The grayish-white spots and streaks of false membrane on the tonsils and other parts of the fauces are at first quite superficial, and even during the first twenty-four hours they increase but little; they then, however, assume a more yellowish or dirty gray color, and become gradually more prominent by increase in thickness, so that they appear like layers of tissue placed on the mucous membrane. At the same time the increased redness and vascularity diminish, as also the swelling of the adjoining mucous membrane, and this frequently takes place so quickly that in some cases, even on the second or third day, we may find the diphtheritic membranes attached to a mucous membrane

which is already normal in color and vascularity. On the third or fourth day, rarely on the fifth or sixth, the false membranes, which have been gradually loosening their connection with the mucous membrane, finally become completely detached, leaving behind them a smooth and wholly intact mucous membrane, which at most may be somewhat hyperæmic in spots, but never eroded.

When the termination is not so favorable,—and there is nothing in the course of the disease during the first few days to indicate such a result,—the process continues along for several days at about the same height which it had reached on the first day. The diphtheritic spots do not enlarge, or the increase in size is scarcely appreciable; they show, moreover, no increase in thickness, and the surrounding mucous membrane is reddened and swollen only in slight degree. The fever, too, is either insignificant or has disappeared, the temperature is scarcely elevated above the normal, the pulse is slightly accelerated, the difficulty in swallowing is nearly gone, the appetite even may be good, thirst is not increased, and the general condition of the patient seems to be quite satisfactory. The cervical and submaxillary glands, which perhaps had already become swollen and tender, do not become more swollen and painful; at the same time they do not diminish at all in size, and patients repeatedly call attention to them in detailing their symptoms.

On the fourth, or perhaps even as late as on the sixth day, the fever, which had nearly subsided, suddenly increases in an extraordinary manner. The temperature rises to 103° or 104° Fahr. The pulse numbers usually between 120 and 130 beats to the minute. The head is hot and painful, the brain confused. A feeling of dryness and burning in the throat and pain in swallowing come on, and the condition of the patient gives the impression that the whole organism is severely affected. If we now examine the mouth and fauces, we may observe in the course of a few hours a rapid extension of the diphtheritic membrane. A few disseminated spots run together by rapid growth and present a single grayish-white surface, often two centimetres (three-fourths of an inch) in diameter. On parts which were at first only reddened and slightly swollen, or even quite normal in

appearance, false membranes of considerable size may quickly form, and the inflammatory injection and swelling then extend over the greater part of the mouth and fauces. The disease, however, has now assumed the croupous form, and its symptoms will be those described under that form of the disease.

II. *Croupous Form.*

We have seen that it is quite possible for the catarrhal form of the disease to progress unrecognized, in many cases, by reason of slight infection and symptoms hardly appreciable, or for the attention not to be directed to the true nature of the affection until the fourth or sixth day, when a violent exacerbation of all the symptoms may occur,—and in fact the mistake is only too often made of considering this the onset of the disease; on the contrary, in the croupous form the symptoms at the very start alarm even a phlegmatic patient, or parents who are still less easily aroused to danger.

The disease begins in adults, as in children, with marked symptoms of fever, with an elevation in the temperature of the body of four or five degrees (Fahr.), or even seven degrees (Fahr.), and with an increase in the pulse-rate, which is oftentimes extreme; or it begins with light chilly sensations and subsequent rise in temperature, while the true chill, which ushers in certain acute exanthematic fevers, and inflammation of internal organs, does not characterize diphtheria. Together with these signs of fever there may be vomiting, and this may be repeated several times without the presence of any special gastric complication. Patients may complain of a stupid feeling, of pain in the head and neck, or in the loins, of debility, weakness in the limbs, a feeling of heat, and increased thirst, and they may be restless or inclined to drowsiness. Children are apt to sleep during the daytime more than is natural for them, and to be restless at night; nocturnal delirium, occasionally even convulsive movements, which may exceptionally rise in intensity to an eclamptic attack, have been observed.

Accompanying these signs of general disturbance, either immediately or soon after their occurrence, come the first sub-

jective signs of a local affection of the throat, *i.e.*, a sensation of dryness and burning, as well as pain on swallowing. The intensity with which these throat symptoms first manifest themselves may indeed be very different in different cases, so that in some cases they may excite the liveliest expressions of suffering, while in others, even in adults and sensible children, such complaints can hardly be elicited even by close questioning.

The swelling of the submaxillary and cervical glands, which receive vasa afferentia directly from the seat of disease, is never absent at this stage, and the degree of this swelling is commensurate with the extent of the local affection of the mucous membrane on one or both sides of the throat. We find the affected glands enlarged, hard, sensitive to pressure, and at times the contiguous connective tissue is also more or less infiltrated and painful.

The mucous membrane of the mouth and fauces shows at this time, in rare cases,—and then usually only in children and youthful individuals,—a marked inflammatory reddening; there is usually a dark-red livid color, which is especially marked on the tonsils, arches of the palate, posterior wall of the pharynx, and on parts also of the soft palate. The tissues appear to be infiltrated with fluid and softened, and the uvula, which is usually involved in the rapid extension of the process, becomes œdematous from infiltration, and is not infrequently swollen to twice its natural volume; its color at the same time is pale yellow, or reddish, its surface glistens as if with moisture, and its whole substance seems filled with a watery infiltration. In addition to these changes the submucous tissue, the tonsils, and the textures lying still deeper, take an active part in the inflammation, and a considerable increase in size takes place in these parts.

A few hours only are now requisite for the development of false membranes, two or three millimetres (from one-twelfth to one-eighth of an inch) in thickness, especially on the tonsils and soft palate. At the first examination there will be found either small false membranes, a few millimetres in thickness, or only a yellowish, sticky secretion in the furrows, or at the mouths of the glands of the one or the other tonsil; while scarcely ten or twelve hours later we find the superficial parts of the mucous

membrane permeated with a yellowish moist infiltration, which may be so great that the parts involved stand two millimetres above the surface of the adjacent normal mucous membrane. At this point it is easy to convince ourselves that the continuity of the surface remains unbroken, that an exudation upon the membrane has not occurred. In cases where false membranes were already present, we find that the grayish-white color of these passes without any break into the yellowish color of the infiltrated, jelly-like portions of the mucous membrane. If we examine the patient again, ten or twelve hours later, we find that the whole infiltration of the mucous membrane has now assumed a grayish-white, or rather a dirty grayish color, and that a thick false membrane, like leather, is present. If such an infiltration extends over the swollen, œdematous parts of the soft palate and uvula, the surface of the mucous membrane gradually loses its moist, translucent aspect; it becomes drier, more cloudy, assumes gradually a tougher consistence, and an appearance like bacon, until finally, after a few hours, these parts also are changed into the same grayish-white false membrane, which not infrequently encloses the uvula as with a leather covering. These thick, leather-like false membranes may be removed, with proper care, in large strips, or even in their entirety, both when they are yellowish and show a resemblance to bacon, and in the later stages, when they form a dirty-grayish, tenacious, elastic substance. The mucous membrane beneath is found then to be deprived of its epithelium, and colored a yellowish-red, or even a darker shade of red; its surface is covered with numerous capillary hemorrhages, and the tissue itself is filled with well-defined extravasations of blood, some of which reach the size of a barleycorn. The surface is perfectly smooth, except where the epithelium is wanting; in these places, however, there is no loss of substance nor any trace of mortification. In such cases the formation of a second membrane over the entire part cannot occur. After the lapse of from eighteen to twenty-four hours a layer of pus forms here and there on the mucous membrane, in the places where it has been deprived of its epithelium; under this covering a slow process of healing may take place, if the case does not end

fatally; more frequently a second fibrinous exudation forms over these spots, and thus a second crop of false membranes is produced.

Course and Termination.

As the diphtheria progresses in its course, the general and local symptoms do not always increase proportionally. Even while the exudation is on the increase, the fever may diminish, the temperature of the body may stand but little above the normal, the pulse may increase from twelve to twenty beats in the minute, the general condition and state of the strength may improve, and still the danger of a fatal result may be in no respect diminished. In the same way the difficulty in swallowing, which in the beginning of the disease gave so much annoyance, becomes less, and even so trifling as scarcely to be noticed, while the diphtheritic membrane spreads slowly through the cavities of the mouth and fauces.

In most cases, however, the fever increases, and, when the course is rapid, this increase is in direct relation to the local disease, and when, in the following days, it seems to diminish in intensity, unless the disease has come to a standstill, or the process of healing has begun, a condition of collapse and of adynamia may follow, the fatal result of which may take place in twenty-four hours (compare septic form). The difficulty in swallowing increases also proportionately with the advancing inflammation, swelling, and exudation, but never reaches that extreme degree which is observed in phlegmonous angina. A secretion of tenacious mucus, which clings to the walls of the fauces, gives rise to wearisome and painful efforts to clear the throat, and the tenaciousness of the secretion does not diminish until the local inflammation has begun to subside. In other cases the sense of heat and dryness in the mouth and fauces, which in the beginning of the disease is so marked, gives place to the secretion of a semifluid tenacious mucus, or even to a true salivation, in cases where the salivary glands also become affected. Unless the mouth is kept carefully cleansed with disinfecting gargles, and thoroughly syringed out, the breath of the

patient gives out a peculiar, and in the highest degree offensive smell; and if the decomposition of the secretions and exudation goes on rapidly, this odor may so increase in intensity as to suggest sphacelous disorganization of the tissues. So long as inflammation has not attacked the larynx, producing exudation, the respiratory process and vocalization also remain unchanged; but if the disease extends to this region, the changes produced will be the same as those caused by any catarrhal or phlegmonous angina.

The swelling of the cervical and submaxillary glands, which is apparent in the very beginning of the disease, increases in intensity together with the gradual increase of all the symptoms, and by degrees glands which are situated farther away, but whose vasa afferentia stand in connection with the centre of infection, become involved and changed into knotty, painful tumors. The stools are usually normal, or the patient is constipated. Diarrhœa is, on the whole, rarely observed, and is for the most part due to some complication. The examination of the urine is important, even in the first days of the disease. As long as the fever continues the disease is on the increase, and fluids, which are then so much needed, can be taken but sparingly on account of the mouth affection; the secretion of the urine continues diminished, and the urine is deeper in color and richer in salts. The most essential and characteristic change, which can be demonstrated in the composition of the urine, and not infrequently at an early period, shows itself in the presence of albumen, together with epithelial and hyaline casts. This sign is of the greatest importance. The affection of the kidneys, at a time when the diphtheritic process remains confined to a small portion of the mucous membrane, points to a rapidly developing general infection, and enables us to distinguish, in doubtful cases, diphtheria from similar exudative forms of inflammation (croup); still, albuminuria is not a constant symptom, and in reference to the frequency of its appearance the opinions of authors vary greatly.

According to Ebert's experience, two out of every three cases of diphtheria, on the average, are affected with albuminuria; while Lewin has noticed, that in regard

to the occurrence of albumen and its amount in the urine, both of these vary greatly in different epidemics, and also at various periods of the same epidemic. The presence and amount of albumen afford, in most cases, no means of determining the final result of the disease. Diphtheria may, under intense fever, result fatally by rapid extension of the exudation into the air-passages or under symptoms of blood-poisoning, and yet the urine may contain only a moderate amount of albumen, or none at all. Demme found constantly, in severe cases, blood-corpuscles and hyaline casts together with albuminuria, to which were added in a remarkably short time epithelium from the tubes of Bellini.

In a number of these cases dropsy and anasarca occurred. Similar observations of extensive nephritis, in consequence of diphtheria of the throat, have also been published by Bartels, who states that about fifty fatal cases of this nature—for the most part associated with suppression of the urine and general dropsy—have occurred in the practice of his colleague, Dr. Kardel, partly in Kiel and partly in the neighboring villages. Finally, albumen appeared not infrequently in the urine in sporadic cases, but usually only for a short time, often disappearing in a few days, and perhaps appearing again for a short time at a later stage of the disease. In rare cases albuminuria may develop at a time when the local changes in the throat are in process of healing, or are nearly well. According to the observations which I have been able to make during the last ten years, the amount of albumen excreted with the urine of those adults in whose cases an opportunity was afforded of making a quantitative analysis, was nearly proportional to the intensity of the disease; and in those severe cases which threatened the patient's life, or indeed resulted fatally, the amount of albumen in the urine passed during twenty-four hours was from one to three drachms, and six or eight weeks after the healing of the throat affection albumen could still be demonstrated in the urine. Even a small quantity of albumen in the urine will sometimes enable us to determine the degree of the general infection, especially in cases where the local disease reaches only a medium intensity. I have known of mild cases of that kind, accompanied by very little fever, where the patient was debilitated for months by a condition of oligæmia and inanition, associated with continued albuminuria.

The further progress of diphtheria is as follows :

(*a.*) In favorable cases, those in which the disease has not extended beyond the mucous membrane of the fauces, recovery takes place in a gradual manner;

(*b.*) Or the disease extends slowly, by continuity of the mucous membranes, to the adjoining organs, above into the cavities of the nose, the tuba Eustachii, and even into the middle ear, and downwards into the larynx, trachea, and bronchi ;

(*c.*) Or, the disease having been accompanied from the very start by symptoms of severe infection, the patient dies, under

symptoms of rapid poisoning of the system, usually on the fifth or the seventh day, more rarely on the ninth, tenth, or eleventh ;

(*d.*) In certain cases gangrene appears in the parts attacked, and then death nearly always ensues.

Termination in Recovery of Health.—When the disease is inclined to terminate favorably, the beginning of the healing process shows itself commonly at the end of the first or beginning of the second week, and this occurs with a simultaneous improvement in the local and general symptoms.

The exudation of fibrinous material on the affected mucous membrane ceases, the different false membranes become gradually more sharply bounded, and their edges stand more prominently above the surface of the mucous membrane. At the same time the swelling of the mucous membrane itself diminishes more or less, and, as a rule, the injection becomes less and is confined to the immediate edges of the false membrane. The membrane separates in small portions from its base, or peels off in large patches ; just before this occurs, however, the membrane very often increases in thickness from an infiltration of pus. The loosened membranes are thrown off by the patient's efforts at coughing or clearing the throat, or without any such attempts ;—and this is especially the case with pieces of large size, while smaller pieces are for the most part swallowed, especially by children. The places where the false membranes were attached remain for some days slightly injected ; elsewhere the mucous membrane has already resumed its normal appearance.

The subsidence of the general and subjective symptoms follows, as a rule quickly, frequently disproportionately soon, so that the patient hardly feels unwell ; and this may be the case while larger or smaller false membranes in the process of being detached are still to be seen on the mucous membrane of the throat. The fever yields and almost disappears at this time, the temperature of the body sinking to the normal, and even one or two degrees below ; the pulse also diminishes steadily in frequency, and shows on the second or third day the normal rate, or continues quickened until complete restoration, or, perchance, some days longer. The pain in the throat and the trouble in swallowing usually improve when the inflammation and exudation begin to

subside, and even at the end of from twenty-four to forty-eight hours after this the patient may be quite free from these annoying symptoms. The tongue clears, the appetite improves, the skin grows moist, the urine becomes more plentiful, and its color lighter. The feeling of general malaise vanishes, sleep becomes quiet and unbroken, and only muscular weakness and the signs of exhaustion, more or less marked, are comparatively slow to yield.

In this way, then, does the healing process become complete and lasting; or, on the other hand, the patient may, after a few days, experience a relapse, which again usually gives place to improvement; or finally, after an apparent recovery, sooner or later, the signs of secondary affections and diphtheritic paralysis set in.

To state the various pathological changes in the course of the disease is a difficult task. The period of exfoliation of the membranes is dependent partly on the extension of the infection, the character of the epidemic, the reactionary power of the affected organism, and the treatment adopted. This exfoliation may begin on the fourth day, and even earlier, or not until the sixth or eighth day, or even the eleventh or twelfth day of the sickness, and may be finished in from two to four or more days; when relapses take place, weeks may pass before the mucous membrane of the throat is quite free from diphtheritic deposits. The entire duration of the disease can scarcely be reckoned at less than ten days; in most cases it extends to over two or three weeks.

Diphtheria of the Nose.

During the first days, or later on in the disease, the diphtheritic process may advance from the throat upwards into the naso-pharyngeal space, may proceed from the uvula and from the borders of the palatine arches, passing from the anterior to the posterior surfaces. More rarely, extensive exudations start from the posterior wall of the pharynx and spread continuously upwards towards the base of the skull and the superior wall of the naso-pharyngeal space, from which point they pass onwards

toward the vault of the posterior nares, and the superior attachment of the septum.

At first the patients complain of a sense of pressure and a stopping up of the nasal passages which interferes with their breathing, and they endeavor to rid themselves of the annoying sensation by making various efforts to blow through the nose, by which means they succeed in expelling muco-purulent masses of greater or less size. The symptoms are rapidly followed by the additional ones of an acute catarrh. An abundant discharge comes on, which at times is of a muco-purulent character, at times thin, watery, and discolored. Later, though often but a short time after, when rapid decomposition of the accumulated deposit has taken place, the discharge is converted into a foul-smelling product, of brownish color and mixed with blood. The skin about the nostrils, as well as on the upper lip, is reddened and excoriated by the flow of the acrid secretion. Such excoriated surfaces are generally soon transformed into ulcers, the surface of which is covered with a grayish white diphtheritic coating.

Epistaxis occurs repeatedly in the very beginning, but more frequently in a more advanced stage of the nasal affection ; it may take on a threatening character when signs of septicæmia have already manifested themselves and large ulcerations have formed in the nose. Under certain conditions the hemorrhage may directly occasion death. If the diphtheritic process extends to the lower nasal fossa, and the nasal portion of the lachrymal duct, the latter may become impassable and epiphora may ensue, caused by the swelling of the mucous membrane, or by the obstructing false membranes ; through this duct also the process may reach the submucous tissue of the eye, and give rise to conjunctival diphtheria of the lower lid. When the disease attacks the mouths of the Eustachian tubes, the patient complains of a ringing, buzzing, or roaring noise in the ears, and piercing pain there, which is much increased by swallowing,—in other words, of symptoms similar to those of simple inflammation of the middle ear. In testing the acuteness of hearing, a marked loss will be demonstrated. If the disease passes through the Eustachian tube into the middle ear, and reaches

the inner surface of the tympanum,—which latter, with the ossicles, will be covered with false membrane,—in the most favorable cases, after the membrane has been thrown off, the drum-head will be perforated and a puriform fluid will flow from the external ear.

Although these symptoms develop rapidly, the diagnosis of a commencing diphtheria of the nose is not difficult, and it is scarcely possible in the first two days to confound it with simple catarrhal rhinitis, which sometimes accompanies diphtheria. The conditions are quite different when the process attacks the mucous membrane of the nose first, and either remains confined to it, or from thence gradually invades the parts lower down. Besides the increase in the local and general symptoms, which belong to simple acute catarrh, such as fever, great swelling and tumefaction of the nasal mucous membrane, there are usually no symptoms present which enable us to recognize the disease at its inception. It is only when the infection appears in the anterior parts of the nasal cavities, near the nostrils, on the septum and the anterior surfaces of the turbinated bones, and false membranes develop there, that a diagnosis can be positively made by inspection.

On the other hand, when the process affects the upper and more deeply situated portions of the nasal cavities, the diseased parts cannot be seen by an ordinary examination, but require the aid of a rhinoscopic mirror in the pharynx; favoring circumstances may then permit a definite opinion to be formed. When this examination, especially in children, is impracticable, our surest means for determining the true nature of the affection lies in a careful observation of the course of the disease, and an examination of the matter expelled from the nose, in which fibrinous coagula and fungi in great abundance are easily demonstrated. In certain cases the development of diphtheritic layers upon fissures (Wertheimber) and excoriations, or other abraded parts near the nose, leads to the recognition of the disease.

In the severest cases a moderate reddening of the nose is observed externally, or an œdematous swelling, with a remarkable pallor, and peculiar glistening appearance of the skin. Swelling of the cervical glands, and those situated more deeply, is not present so long as the disease has not attacked the parts from which their vasa afferentia take their rise. The course of the disease is in most cases comparatively brief, terminating in a few days. When the process, without having attained a considerable extent, is disposed to heal, the false membranes gradually loosen; the unpleasant odor from the nose, and the discharge, mixed with ichorous fluid, disappear; an excretion of a more mucopurulent character sets in, and may last for several days; and

finally complete recovery takes place. When, however, as is almost always the case, the affection, independently of disease of the larynx and throat, leads to a fatal termination, the local signs grow rapidly worse. The exudations, loosened to a great extent, decompose, and are transformed into a thick, stinking, ichorous fluid, which erodes the underlying mucous membrane, and may lead to ulceration of the same, and even to disease and destruction of cartilages and bones (Nassiloff). A condition of adynamia and collapse develops rapidly, and the patient dies under signs of septicæmia and general poisoning.

DIPHTHERIA OF THE LARYNX.

The possbiility of an extension of the diphtheria from the throat into the larynx and air-passages below is to be feared in all forms of the disease.

The more extensively the mucous membrane of the pharynx is covered with false membranes, and the lower down they extend into the pharyngeal space, the greater is the danger that the inflammation, in consequence of the continuity of the mucous membrane, will reach the larynx and there make its appearance. But in other cases also, in which exudations a few centimetres in diameter appear on the tonsils and in the fauces, while larger and nearly normal portions of the mucous membrane are unaffected, diphtheria of the larynx may still occur, and at an early period. This, like the exudations developing here and there on the tonsils and mucous membrane of the fauces, is either induced in the very beginning by multiple infection or localization, or it follows possibly—the parts being predisposed to the disease—by secondary infection, through inspiration of the poison contained in the cavity of the mouth, while the deeper-lying portions of the pharynx may be passed over.

There are cases on record in which diphtheria localized itself first in the mouth, on the lips, and from these points, skipping the fauces entirely, at once attacked the larynx. Finally, there are rarer ones, in which the diphtheria involved the larynx first, and the mucous membrane of the fauces secondarily, while it also extended downward into the trachea and bronchi.

The advance of diphtheria from the pharynx into the larynx occurs almost always in the first few days of the disease, usually between the third and sixth day, not infrequently, however, on the eighth or tenth day. In a few protracted cases I have observed an infection of the larynx, even on the thirteenth and fourteenth days. The younger the patient, the greater is the

danger that even the lighter forms of the disease may involve the larynx, while the more extensive inflammations take this dangerous course almost invariably. In adults, too, those severe forms of infection, which are accompanied by high fever and rapid exudation of thick, leather-like masses on the dark-red, livid, mucous membrane, extend in a short time to the epiglottis and the interior of the larynx. The degree of physical strength and the individual constitution of the patient exert an influence, not to be underrated, upon the intensity and extent which diphtheria in its course attains. The weaker the body has become through previous diseases and other debilitating influences, the more dangerous, as a rule, is the process. Age seems to offer the same conditions, and the majority of cases of diphtheria in adults, in which I observed extension of the disease into the larynx within the first four days, were men between sixty and seventy years old. Sex seems to have no influence in superinducing the laryngeal affection.

If diphtheria has, in the manner described, invaded the larynx, the symptoms which now complicate the previous ones differ very remarkably, according to the age of the patient; this difference has led some to describe—without regard to the anatomical changes—two very different forms of inflammation, which may be produced by diphtheria spreading from the fauces into the larnyx. "In children," it was said, "the croupous inflammation was apt to occur, while in adults it was chiefly the diphtheritic." The cause of the difference in the symptoms lies simply in the difference in the capacity of the larynx and air-passages of children and adults. In children the alarming symptoms of marked mechanical obstruction—causing a dyspnœa, which may in certain cases increase even to asphyxia—obscure all the other symptoms; while in adults, in whom these conditions do not so easily establish themselves—by reason of great space in the parts mentioned,—the symptoms of infectious disease continue to develop without any remarkable modification. Since the symptoms occurring under these circumstances, and the course and termination of the same are so different, it will be necessary to describe separately the processes and symptoms, as they appear in children and adults.

(*a.*) *In Children.*

To determine whether a diphtheritic process has in reality commenced in the larynx, may, in certain cases, be a difficult matter, perhaps impossible at first, if a decision is to be based on the symptoms alone. A simple inflammation, such as is likely to occur in the course of diphtheria, just before the formation of false membranes, may, when it appears in the larynx, cause symptoms like the diphtheritic process itself,—*i.e.*, a hoarse, metallic ring of the voice, dry cough, labored and sibilant inspiration, spasm, suffocation, asphyxia, and even death,—and yet not be followed by fibrinous exudation.

When a laryngoscopic examination can be made in the case of children sick with laryngeal diphtheria, all the parts of the larynx will be found intensely reddened and swollen, the epiglottis thickened to twice its natural size, and the yellow color of the cartilage, which normally shows through its covering, no longer distinguishable; the aryteno-epiglottidean folds, the false and true cords, are greatly swollen, and are covered more or less with a grayish-white exudation, or the interior of the larynx itself is lined as with a white, leather-like covering, and the glottis is narrowed. Tenacious exudation and purulent mucus, which push up from the deeper parts of the air-passages, often adhere between the vocal cords, and are driven up and down in the narrow cleft by the forced respiration.

Accompanying these local changes in the larynx of a child, there are also signs which, by their intensity and by the danger with which they threaten respiration, excite alarm and vigilance in the most indifferent beholder. If in the beginning of the disease, while the diphtheritic process was extending slowly over the mucous membrane of the fauces, there was only moderate fever and a mild general disturbance, yet, with the commencement of inflammation and exudation in the larynx, the fever will rise rapidly to a higher and higher degree. All the symptoms indicate an affection of the larynx mainly inflammatory in character; the parts adjoining the larynx and external to it become turgid and somewhat painful; the cervical and submaxillary

glands, perhaps at first only moderately enlarged, become hard to the feel, painful and swollen, and often form large nodules, which are sensitive to pressure and may even be exquisitely tender; the respiration is quickened and embarrassed; the inspiration is prolonged and labored, and accompanied by a whistling, hissing sound; cough comes on, occasions great suffering, and has also a peculiar barking, flat sound, without resonance, which, on account of its peculiar character, has been called the "croupy cough." The hoarseness and roughness of voice also increase correspondingly, and often at an early stage pass into complete aphonia, while the act of speaking itself causes no pain. All the symptoms, which are exceptionably prominent in laryngeal croup, develop in a short space of time, and press rapidly on to the close. Now since the important signs of the disease are similar to those of laryngeal croup, the symptomatology of the two affections may be given in one description. The same physical changes as are characteristic of a simple inflammation with fibrinous exudation upon the inner surface of the larynx, trachea, and bronchi, cause the same functional derangements of the lungs and respiratory muscles (diaphragm and others) in both diseases (compare croup). Only in rare cases do these disturbances in the respiratory apparatus fail to reach the degree above stated, and the peculiar signs of the infectious disease—the symptoms of blood-poisoning—become more and more prominent, and under them the patient finally succumbs.

COURSE AND TERMINATION.

Diphtheria of the larynx and lower air-passages in children usually runs its course in a few days: in from two to eight days, or more rarely as late as the tenth or twelfth day, either a fatal termination or convalescence may take place. In those cases which are said to have run their course in from twenty-four to thirty-six hours, and were regarded as diphtheritic from the very outset, the probability is that the signs as above described were overlooked.

Death is the common result, if the disease extends to the lower air-passages. It occurs either during a long-continued

paroxysm from spasm of the glottis, or from mechanical obstruction of the larynx, trachea, or bronchi, through secretion and false membrane, or from insufficient decarbonization of the blood, due to its unequal distribution. On the other hand, this inequality in the distribution of the blood is due to the fact that emphysema and anæmia have established themselves in the parts open to the circulation of air, while in the collapsed parts, to which the air does not have access, there is hyperæmia. Finally, the fatal result may be brought on by concurrent pneumonia, or œdema of the lungs, more rarely of the glottis, or by a combination of the causes mentioned. In many cases death results from some affection of the nervous system,—either under general convulsions, through changes in the nutrition of certain parts of the brain consequent on the supply of too little arterialized blood (Kussmaul); or under a condition of adynamia and torpor, which gradually develop while the disturbances in the respiration become less conspicuous.

When *recovery* begins there is a decrease both in the fever and in the severity of the laryngeal symptoms, not infrequently with an alarming increase in the secretion of urine, severe sweating and epistaxis, while the fibrinous masses in the larynx are thrown off in cylindrical or irregular forms,—the children either expectorating, or swallowing them. That false membranes may liquefy and be absorbed, at the seat of attachment in the larynx and trachea, may be positively denied. Since fresh exudations may form, after false membranes have been repeatedly thrown off, recovery cannot be positively announced; in fact, the termination is almost always fatal when such new formations take place. Hoarseness, continuing a longer or shorter time after recovery from the disease, is to be ascribed to a flaccid condition of the vocal cords and atony of the laryngeal muscles.

(*b.*) *In Adults.*

In adults we rarely have the opportunity of observing the quickly increasing symptoms of dyspnœa and spasm of the glottis, which are the constant signs of this disease in children. We find them only in youthful patients, and in those individuals of advanced age, especially women, in whom the calibre of the glottis is so

small, that the inflammatory swelling of the mucous membrane and the formation of false membranes may give rise to stenosis. In the same way attacks of asphyxia and cramp are observed in aged persons, when the nervous system is inclined to reflex symptoms and irritative conditions; in such persons the clinging of the secretion to the mucous membrane and the presence of false membranes occasion sufficient irritation to bring on spasm of the glottis.

When the diphtheria extends to the larynx in adults, the symptoms, which are of constant occurrence, are those of functional disturbance induced by inflammation and exudation: changes in the voice (roughness and hoarseness), dry cough without resonance,—which in many instances is first discovered by intentional attempts at coughing, since spontaneous cough from tickling or irritative sensations may be lacking,—and, finally, audible respiration, with rough, whistling inspiration, which has its cause principally in the physiological action of the glottis. During each inspiration the vocal cords project more or less into the glottis, and again recede during expiration, so that under certain conditions the false membranes on the vocal cords may induce a temporary stenosis of the glottis as the cords approach each other in inspiration.

On laryngoscopic examination, those portions of the mucous membrane which are free from false membrane appear bright red, or dark red, bluish, swollen, and not infrequently considerably thickened. In many of the cases which I had the opportunity of examining, the anterior surface of the epiglottis was still free from false membrane, its mucous membrane uniformly reddened, livid, swollen, and the whole organ twice as thick as normal; on account of the uniformly extensive swelling, nothing was to be seen of the plexus of veins, which in this region is normally more or less markedly developed. The posterior surface was generally found to be covered with a thick, white, dirty-grayish or grayish-red membrane, which extended over the greater part of the ary-epiglottic folds, and the true and false cords, like a thick leather covering; in a few cases, the intervening space between these cords, *i.e.*, the entrance to the sinuses of Morgagni, was completely obliterated, and a single fold of false membrane, with a surface extending from above and outwards, downwards and inwards, shut in both the duplica-

tures of the mucous membrane. In such cases the mobility of the vocal cords was greatly diminished, the speech partly aphonic, and the respiration rough and whistling; stenosis of the glottis did not occur in these patients,—men between forty-five and fifty years of age,—but death was due to toxicæmia. I found the mucous membrane over the posterior surface of the arytenoid cartilages in most cases still free from false membrane, even when the exudation had already spread to the sinus pyriformis, and the external surface of the ary-epiglottic folds was already covered with patches of false membrane. When the vocal cords were more mobile than usual, and the tracheal region could be seen, which rarely happened, the mucous membrane was seen to be covered with false membrane. When the false cords or small portions of them showed pseudo-membranous patches, the true cords were for the most part reddened and swollen, but still free from fibrinous exudations, while the formation of false membrane, when it had once occurred on the true cords, usually extended so rapidly into the trachea that the latter was always covered at the same time with the exudation. The reason for this lies possibly in the fact that the ventricle of Morgagni lying between, forms a cavity between the false and true cords, and so acts as a barrier to the extension of the disease in that direction.

In adults, the usual course of diphtheria in bad cases, when it involves the larynx, leads to a fatal result by general blood-poisoning. The symptomatology and course of these cases, which belong to the so-called septic form, are described farther on, under this title.

The disease may either pass into the septicæmic form, or it may end fatally in adults (as the observations of Löwenhardt show) in a peculiar manner, *i.e.*, an extensive separation of the membrane may produce a mechanical closure of the glottis, and death be brought on by suffocation.

Finally, there are cases also in which, during the septicæmic process, without an extension of the diphtheritic process to the larynx, collateral œdema may develop in the submucous tissue at the entrance of the larynx, and give rise to symptoms of laryngeal stenosis: aphonia, hoarseness, croupous cough, stridulous inspiration, fear of suffocation, swelling of the neck, and red or even cyanotic color of the face. This stenosis of the glottis appears to arise especially in those cases of diphtheria of the throat, in which, coincident with deeply penetrating infiltration, or

necrosis of the tissues, tumefaction of the cervical glands, and of the periglandular connective tissue, quickly reaches an extreme degree (Wertheimber).

III. *Septic Form.*

In diphtheria there is great danger that the products of an extensive disorganization of the tissues may pass into the circulation, and that a poisonous action, similar to that caused by products of putrefaction in general, may manifest itself (Billroth). It is only in rare cases that the toxic symptoms appear prominently on the first or second day, leading in a short time to the fatal result; as a rule, however, they develop gradually, after the disease has already existed for some time.

Shortly after the exudation has appeared in greater or less amount, or perhaps not until after the false membrane has been present for some time, without having increased appreciably in size, it is noticed that the breath from the mouth of the patient becomes more and more foul-smelling and fetid; the false membranes assume a dirty-gray, brownish appearance, lose their properties of resistance and toughness, become soft, brittle, and break down at many points into a grayish-brown, semi-solid, greasy layer, which shows the greatest virulence when inoculated upon animals. The fluids from the mouth, combined with the ichorous products from the decomposing and liquefying membranes, assume the character of a stinking, corroding ichor, which in flowing from the mouth causes reddening and excoriation at the corners, and small fissures or denuded parts are quickly changed into extensive ulcers covered with a dirty-grayish coating. In spite of these extraordinary processes, on removing the decomposing covering, the surface of the subepithelial tissue is found smooth and intact, or here and there we find a loss of substance, which represents either a shallow ulcer, with uneven base, prone to hemorrhage, or a deeper ulcer, with irregular edges, the surface of which, for a long time, remains covered with a dirty-gray, semi-solid layer, and sloughy remnants of tissue. Depressions and furrows, which existed in the tonsils before the attack, and during the early stages were filled up with exudative products, must not be confounded

with the ulcerations above described. It is only in the rarest cases that an extensive destruction of tissue, such as gangrene, occurs (see below). The thick, grayish-brown, disorganizing false membranes, which cover the posterior walls of the mouth and of the pharyngeal space, and appear at various points as thick, friable shreds, three or four millimetres in thickness, or as shaggy, pultaceous masses, may on superficial examination give the impression of gangrenous destruction of the fauces, while both the mucous and submucous tissues are found to be intact on removal of the putrefying masses of exudation, and the process goes on to healing without loss of substance or cicatricial formation.

As may be inferred from the color of the false membranes, numberless capillary hemorrhages occur at this stage on the surface of the mucous membrane; the blood, in part, infiltrates the false membranes, which, during the rapidly progressing decomposition, soon assume a brownish or blackish color; and in part—especially where the hemorrhages are copious—is poured out between the surface of the mucous membrane and the false membranes, and to a certain extent separates them. The mucous membrane itself, when laid bare by careful removal of the false membranes, is found to be covered with ecchymoses which vary in size from that of a pin's head to that of a lentil, and the number of which stands in exact relation to the intensity of the process; at one time, therefore, we find only a few points of extravasation, while at another the whole surface is strewed with larger and smaller capillary hemorrhages, lying near or running into one another. Ecchymoses are also to be seen on those portions of the mucous membrane of the mouth and fauces which have not been affected with the exudative process.

As a result of these changes in the mucous membrane of the fauces, the lymphatic vessels and glands become inflamed, the latter forming on one or both sides of the neck, a broad, flattened, nodular swelling, sometimes hard and tough on palpation, sometimes soft and doughy.

The periglandular and subcutaneous connective tissue may also swell to a certain degree, so that the neck and face pass into one another without apparent boundary lines, while the tense

skin appears smooth and shining and the swollen parts feel at times doughy and at times as hard as a board.

Course, Duration, and Termination.

The septic symptoms, when once they have appeared, last as a rule but a short time.

In severe early infection, especially where the epidemic is of a malignant type, the earliest symptoms afford clear signs of blood-poisoning, and, by the time the first false membrane has formed, the whole organism is profoundly affected; death, in these cases, frequently follows within forty-eight hours; as a rule, however, it occurs on the third or fourth day. In other cases, when the development of the diphtheritic process is slower, and the blood-poisoning from the diseased mucous membrane takes place in a gradual manner, the disease is prolonged, and ends fatally between the tenth and fourteenth days; the first signs of toxic action on the blood having appeared four or five days previously. The disease rarely lasts longer than two weeks, the throat affection being at the start apparently unimportant, and making but slow progress, as in scrofulous, anæmic, debilitated, and cachectic persons. The fatal result follows in consequence of blood-poisoning, exhaustion, and inanition, without the development of any more marked indications of general intoxication.

Like the course and duration of the septic symptoms, so the final symptoms and the causes inducing the fatal result are varied. When the course is rapid the symptoms already described become violent. The phases follow each other in quick succession: the false membranes form on the livid, œdematous mucous membrane, and soon undergo ichorous disorganization; the discharges from the mouth and nose become stinking and corroding: the cervical and submaxillary glands become enormously swollen, and there is œdema of the surrounding connective tissue. The face of the patient becomes bloated, pale, wax-like; his pulse small, weak, irregular, and remarkably slow; the temperature is slightly raised, or may fall below the normal; his strength is gone, but consciousness

remains unclouded even in the last hours (delirium being only exceptional), and death ensues from œdema of the lungs or some affection of the heart.

When the disease takes a less violent course, and exudation and disorganization follow less rapidly, the symptoms of septicæmia develop slowly, but progressively. The patients make no special complaint, they lie quietly on the bed; the face becomes pale and sodden; the exhaustion and loss of strength increase; the appetite fails, or the patient vomits the food taken; at the same time the temperature falls below the normal to between 96° and 97° F., and a cold sticky sweat covers the forehead and extremities. The pulse, scarcely reaching forty or fifty beats in the minute, is irregular and intermittent, and death follows suddenly, as a rule, during some slight motion of the patient, after some excitement of short duration, or during a state of unusual quiet. But even when the disease does not produce such marked constitutional disturbance, or even after a slight degree of improvement in the local and general symptoms has manifested itself, the patient may be seized with fainting and vomiting, after some quick movement on sitting up, or without any apparent cause, and in this state die, or when recovery from this ensues, he succumbs to a following attack. Such attacks of fatal syncope may occur even in advanced convalescence or result from an apparently trifling affection (Mosler), and this is especially likely to happen when, in spite of apparent convalescence, the pulse continues remarkably slow, small, weak, and irregular.

Termination in Recovery.—The cases are very rare in which diphtheria is followed by recovery, when once the symptoms of septic intoxication have appeared.

The first signs that the crisis of the disease has been passed, and the reactionary powers of the system have gained the mastery, are the cessation of the flow of fluids from the nose, gradual clearing of the fauces, diminution in the glandular swelling, while at the same time the signs of septicæmia become less and less marked, and prostration gives way to a condition of general improvement. The diminished temperature of the body rises again, soon reaches 98° F. and attains in some cases even

100° or 101° F., but falls again during the next few days to the normal degree. The pulse, on the other hand, remains small, weak, at times even irregular or intermittent, and often reaches from 116 to 120 beats in the minute. The expression of the patient also improves, the eye becomes brighter, the sallow, pale color of the face passes off, the cheeks gradually assume their healthy, reddish tint, the appetite returns, and the condition of general apathy in which the patient lay gives way to a more hopeful frame of mind.

Convalescence introduced with these signs is usually extremely slow, and is prolonged, even under the most favorable circumstances, through many weeks. Still the disease, when once it has attained the height above indicated, reaches, in rare cases only, such a happy conclusion. Usually secondary symptoms appear, and these may in turn last for weeks and even months, and under unfavorable circumstances may finally occasion the death of the patient.

IV. *Gangrenous Form.*

If diphtheria of the fauces and other air-passages passes into gangrene, the local and general signs of the process are alone prominent. (Compare gangrene of the mouth and fauces.)

When the unmistakable signs of gangrenous disorganization appear on the mucous membrane, the inflammatory and febrile signs commonly give place very quickly to those of general depression and collapse. The features of the face lose their character, the pulse grows frequent and small, the skin cool. Often there are marked chills, metastatic inflammations of internal organs through septicæmia or embolus, erysipelas of the skin, nervous symptoms, meteorism, and involuntary stools, death finally closing the scene.

Only rarely does the process go on to separation of necrosed portions like the uvula, arches of the palate, etc., with corresponding deformities after the healing process is completed.

SECONDARY AFFECTIONS, PARALYSES.

After every diphtheritic affection, under whatever form it

may appear, partial or complete muscular paralyses may occur, and indeed not only in the muscles of the pharynx and larynx, the mucous membranes of which were covered with a diphtheritic coat, but also in all the other portions of the muscular system. Then again, on the other hand, the velum and pharynx may be attacked by secondary paralysis in cases in which these organs were not primarily affected, as for instance where the infection has taken place in other parts of the body through wounds made by blisters or incisions.

Since the paralysis is developed only gradually and slowly, its more characteristic symptoms are seldom discovered immediately after the termination of the local affection, but as a rule appear first during the second or third week after the complete healing of the lesions of the mouth or nose; according to Roger, secondary paralyses may present themselves even from the thirtieth to the fortieth day after this date. The first recognizable symptoms are furthermore concealed by the fact that a muscle is seldom suddenly paralyzed; it is only gradually that more and more of its fasciculi become incapacitated, so that the muscle remains for some time longer partly under the control of the will. After the paralysis has begun it may either confine itself to a limited region or implicate more extended portions, and can even in exceptional cases spread to all the muscles.

The course ordinarily taken by this process is characteristic. Paralysis of the soft palate and pharynx is first noticed; this is followed either immediately or after a short interval by disturbances of vision, while paralyses of the lower and upper extremities occur later. Exceptionally, the fauces have been found entirely unaffected after the paralytic symptoms had already appeared in other muscles. More rarely, paralysis has been observed in the muscles of the larynx, trunk, rectum, bladder, diaphragm, and, finally, of the face. In all these muscles the slowly developing disturbance can limit itself more or less promptly and produce an incomplete paralysis, or the paresis may go on to complete paralysis, accompanied by increased or diminished reflex excitability and electro-muscular contractility.

Paralysis of the Muscles of the Soft Palate and of the Pharynx generally.

In this, the most common paralysis, the soft palate and the uvula hang loosely down and cannot be raised to give the open sound of the vowel *a* as in health. When the paralysis is of one side only, the uvula is drawn toward the healthy side, and when efforts are made to speak, it is drawn still further to this side and upwards. In such a case functional disturbance appears also in difficulty of articulation, deglutition, and in part also of expectoration.

Speech is nasal, thin, like that of individuals with defective palates, and is rendered completely unintelligible when there is any noise in the vicinity and the patient is tired. The patients are not able to pronounce the single letters distinctly, the sounds run into one another, and the palatals are particularly indistinct, because the necessary approximation of the soft palate and the root of the tongue is no longer possible on account of the arrested action of the tensor and palato-glossal muscles.

In many cases difficulty of deglutition first calls attention to the beginning or already existing palatal paralysis. In the attempt to swallow, the patient notices that this function is not so easily performed as formerly, that he must swallow carefully and with greater effort, and that he very often swallows awry. When taking liquid food or while drinking, especially when the head is bent slightly forward, either a portion of the liquid runs out of the nostrils or it is all regurgitated, or, if some of it has fallen into the larynx, it is forcibly ejected, partly through the nose, with violent coughing. The patient can, as a rule, swallow solid food more easily; but still it happens often enough that only a part gets into the œsophagus, the rest going into the naso-pharyngeal cavity, thence into the nose, from which it is removed by blowing.

As a further consequence of palatal paralysis, difficulty of expectoration is finally to be noticed. In such cases the mucus collects generally in larger quantities, and cannot be so easily thrown out, because the muscles which act as constrictors of the

pharynx are paralyzed, and consequently the compression of the expired air, which is necessary to expectoration, is lacking. If under such circumstances the malady be complicated with a bronchitis or pneumonia, the intercurrent processes generally take an unfavorable course, and may even cause a fatal result.

Disturbance of Vision.

Certain disturbances of vision belong likewise among the most frequently occurring partial consequences of diphtheria, and present themselves either shortly after, or, in rare cases, at the same time with, the appearance of the palatal paralysis. Generally the patients first complain that they can no longer read fine print, that when the effort is made they have flashes of light before their eyes and see indistinctly, and their eyes at once feel fatigued. Double vision with squinting often occurs; also vertigo, which is due to defective muscular sensibility.

According to the researches of Donders, these symptoms are caused by a commencing paresis of accommodation, almost always in both eyes, due to paralysis of the internal muscles of the eye, which are supplied by the short root of the ciliary ganglion, whilst in other cases the oculo-motor and the abducens are also included in the compass of the paresis.

Paralysis of the Extremities.

After disturbances in the organs already enumerated, paralytic symptoms appear most frequently in the extremities, and since these muscles are more important and accessible to investigation, the progressive character of the paralysis can be demonstrated. The lower extremities are most often the seat of the paralysis, but it may begin in these and then pass to the upper members.

In the first case the affection begins with a sensation of cold and numbness (a furry sensation), or with sharp pains in the feet, soon followed by trembling of the extremities and paretic weakness, and the patient feels feeble, awkward, and uncertain in his gait. If this incomplete paresis goes on to complete para-

plegia, the patient becomes unable to hold himself upright upon his feet, or to move them voluntarily.

In the second case the patient first notices a sensation of numbness and formication running up from the fingers; his arms become powerless, his hands awkward and incapable of co-ordinated movements, so that he is no longer able to dress and undress himself, or to hold large objects, until finally the paralysis becomes complete, and the attitude of the arms is determined by their own weight.

The muscles themselves of the paralyzed extremities are flaccid and without tone. Electro-muscular sensibility and contractility are greatly diminished or entirely abolished. Not rarely do the muscles atrophy in a short time, and in such cases I have produced, both with the induced and with the constant current, partial contractions, which, however, were too feeble to cause the corresponding movement of the limb. With this diminished motility there is also a reduction of tactile sense, especially at the ends of the extremities, the plantar surface of the foot, and the fingers, and also of electro-cutaneous sensibility, whilst the appreciation of heat in the majority of cases is increased.

Paralysis of the Muscles of the Larynx.

Paralytic symptoms seldom show themselves in the muscular apparatus of the larynx alone, or in immediate connection with pharyngeal paralysis, but in the majority of cases the larynx is attacked only when the paralysis is more general. The paralysis may be partial, involving only single muscles, or general, when all the muscles of the larynx are disabled.

In the first case laryngoscopical examination shows that only one vocal cord has lost its mobility, and is fixed in the position which results from the disability of the paralyzed muscle and the antagonistic and joint action of the others (compare Paralysis of Laryngeal Muscles). When all the muscles are paralyzed, both vocal cords appear motionless during attempts at intonation and respiration, and take a position *which lies in the line of motion between the positions of phonation and respiration, and which therefore is never seen fixed during life. It*

corresponds to the point of equilibrium which results from the suspended antagonism of the muscles in consequence of the general paralysis, and corresponds to the position of the vocal cords in the cadaver. The glottis is opened to the extent of four or five mm. and perhaps even wider, and the vocal cords are completely motionless when the paralysis is complete; only in cases where a moderately strong respiration is still possible are they drawn inwards and downwards by the current of air during inspiration, and forced outwards and upwards by the expired air. Should the paralysis of some of the muscles not be complete, the position of the vocal cords and the amount of their mobility will depend upon the action of these muscles.

The speech of the patient is partly without resonance, hoarse, sometimes rough, guttural, or completely aphonic; cough and expiration are more difficult, while respiration is impeded only by paralysis of both the posterior crico-arytenoid muscles, and not so much by general paralysis; dyspnœa is induced only by increased need of breath, walking, or other active movements.

Besides these disturbances in the motor system, partial or complete anæsthesia of the laryngeal mucous membrane may be caused by paralysis of the superior laryngeal nerve, so that reflex symptoms, cough, or closure of the glottis are no longer produced by contact with the sound (v. Ziemssen).

This diminished or abolished ability to react makes it possible for bits of food to make their way entirely unnoticed into the larynx of the patient, and cause his death, with symptoms of extreme dyspnœa (Peter, Coulon, and others).

The Muscles of the Neck and Trunk, with the Diaphragm,

are generally the last to be attacked by the constantly progressing paralysis, and complete the picture of diphtheritic ataxia. Patients suffering with paralysis of the muscles of the neck and nape are with difficulty able to balance their head upon the vertebral column, and when it falls forward or backward, they are not able to lift it up again without help. If the muscles of the trunk are considerably affected, it becomes impossible for the patient to raise himself from the horizontal position, or to turn himself in

bed from one side to the other; when placed in a sitting posture he sinks together. Since the expansion of the chest during inspiration is steadily rendered more incomplete by the paresis of the muscles of the thorax and abdomen, symptoms of disturbance of respiration shortly appear,—slow superficial breathing and occasional asthmatic accidents becoming constantly more prominent, until finally, with paralysis of the diaphragm, excessive shortness of breath, cyanosis and asphyxia are developed, and death is caused by œdema of the lungs. Should the paresis of the muscles of respiration remain incomplete, and the diaphragm retain some power to act, even the most serious accidents of this kind may pass over and the patients recover.

Paralysis of the Sphincters of the Bladder and Rectum

is observed in some cases simultaneously with, or shortly after the appearance of paralysis of the lower extremities. Ordinarily it appears first during the development of general paralysis.

In other cases the paralysis affects especially

The Sexual Organs,

and men, previously healthy, lose all power of erection, and all sexual desire. This anaphrodisia may last several months, and Trousseau has observed it in all individuals affected with general paralysis.

Duration and Termination.

The ordinary termination of diphtheritic paralysis is in cure. The muscles which were first paralyzed are also the first to recover their contractility, and the duration of the paralytic symptoms depends upon the degree and extent to which they attain.

As a rule the last paralytic symptoms do not disappear before six or eight weeks, in severe cases even three or four months. Exceptionally they last through seven or eight months, and Donders tells of a patient whose paralysis only ended after ten months. In rare cases the paralysis becomes permanent, and subsequent relative health and even life are conditional upon the

effects which this chronic functional disturbance produces in the organism.

A fatal termination occurs, according to our present data, in from eight to ten per cent. of diphtheritic paralyses. It was caused by sudden suffocation, the result of the entrance of large pieces of food into the air-passages; by pneumonia, caused by foreign bodies in the lungs; by inanition, by extension of the paralysis to the muscles of respiration, by intercurrent disease of the lungs and pleura, and finally by paralysis of the heart.

PATHOLOGICAL ANATOMY.

Organs of the Cavity of the Mouth and Pharynx.

The anatomico-pathological changes upon the mucous membranes of the cavity of the mouth and pharynx—inflammation, fibrinous exudation, destruction of the products of inflammation and gangrene, as they appear when accessible to the naked eye and at the autopsy—have been already described in the part relating to the pharyngeal organs; the morphological processes in their development, so far as they have been open to investigation, are as follows:

DEVELOPMENT OF THE LOCAL PROCESS.

I. Catarrhal Form.

Cavity of Mouth and Pharynx.—The signs of a simple catarrhal inflammation, as they appear on local inspection, are, during the first twelve or at most eighteen hours, the only anatomico-pathological changes noticeable. As a rule, further appearances are seen during the following hours upon the pharyngeal mucous membrane, though they may even be observed at the same time with those of the catarrh; these are: the already described whitish-gray, hoar-frost-like coating on the mucous surface, and afterwards the more yellow or dirty-green layers and deposits. Peculiar as these more or less extensive patches and layers may appear upon the inflamed mucous surface, yet,

except the signs of the catarrh, no further alterations of tissue in or upon the mucous membrane itself can be established.

There where the whitish-gray patch appears, rising more or less above the level of the mucous surface, luxuriant growths of round-celled vegetable organisms, micrococcus, will be found to have developed themselves, partly upon the epithelium and partly in its superficial layers, or even extending into its deeper ones, and by their accumulation to have been the chief agents in altering the color and size of the affected parts. The epithelial cells of the outermost, most resisting layer, though covered with thick coats of micrococcus, show no change in form and size, while the cells of the deeper layers appear to be increased in diameter and swollen by absorption of the liquid of the tissues (Weber), and contain each a nucleus which is also enlarged and often sharply outlined. On the upper surface of the epithelium the micrococci will be found to have spread out in irregular masses, to have undermined and lifted up single cells in their growth, and to have formed, by the development of glutinous bunches and colonies, nodules which are sometimes larger, sometimes smaller, and often even of considerable size. Gradually the micrococcus forces its way down between the epithelial cells into the deeper layers; the affected part assumes in consequence of this thickening a projecting beam-like appearance, increases steadily in volume, and appears, finally, as a more or less sharply defined deposit above the level of the mucous surface.

From twelve to eighteen hours later, pus-corpuscles appear in the deeper layers, at first only in small numbers; they are generally coated with micrococcus, and have drawn some into their interior. The longer the process lasts, and the further the micrococcus penetrates into the deeper epithelial layers, so much the more numerous become the pus-corpuscles; they gradually infiltrate in broad lines the subepithelial tissue and the lowest layers of cells, and force their way out in streams and masses between the epithelial cells, which are covered with fungus and the micrococcus balls. Finally, they circumscribe on all sides the fungus growth in more or less thickly crowded masses. At the same time appear among the first advancing pus-corpuscles, or a little later, large young cells, three or four times as large as

the pus-cells, and having large nuclei, which soon appear to be engaged in active proliferation. Like the pus-corpuscles, these cells also can form broad lines of demarcation against the growth of the fungus. Where the cells collect in thick masses, we may see also, besides the rapid nuclear proliferation, an accumulation and infiltration of separate nuclei, which have the size and form of those enclosed in the cells, and are surrounded by a thin, often scarcely recognizable, layer of protoplasm. The deeper layers of pus and young cells are almost entirely free from fungus. *Here cell lies against cell, and constantly widening masses interpose themselves between the micrococcus vegetation and the neighboring tissues*, until finally they loosen the more or less extensive patch entirely from the mucous membrane. Although now the outer epithelial layers are rapidly renewed, the place appears red and injected for some time longer, and may thus be easily distinguished from the paler neighboring surface. During the entire course of this form of the disease there is no secretion of fibrine, and its peculiar net- or framework is not to be found in either the thin or thick patches. In cases which progress favorably the disease ends in a few days with the fall of the patch; when the process advances slowly and the course assumes an unfavorable form, secretion of fibrine takes place, and this form changes gradually or suddenly into the following one:

II. Croupous Form.

The characteristic symptom of this form is the *exudation of fibrine*. Almost immediately after the beginning of the diphtheritic process, or after a more or less free production of pus has taken place for some days, fibrine is poured out not only into the epithelium, which is already infiltrated with micrococcus, but also into the interstices between it and the subepithelial tissue of the pharyngeal mucous membrane.

When the disease appears in this form, the epithelium upon the surface of the rapidly formed false membranes is seen after a few hours to be greatly altered and already in process of rapid necrosis. Here appear those characteristic forms which Wagner

first described as the products of *fibrinous degeneration.* The *surface* of these membranes consists almost entirely of flakes and masses of broken-down epithelial cells penetrated by fungous vegetations, while in the deeper layers the single cells already loosened from one another appear provided with projections and processes in the greatest variety; some having hook- and antler-like forms, while others are only reduced to round, angular, or irregular fragments, and others still are enclosed as in a frame of granular, brush-like clot, in which threads of fibrine, detritus of broken-down cells, and micrococci can be demonstrated. Between these necrosed cells a network of fibrine is developed over larger or smaller tracts, and during the first twenty-four hours the fibres composing this network are found to have a diameter varying from that of a delicate line to that of an elastic fibre. The meshes of the network also are of different sizes, varying from that of a pin's head to that of an alveola of the lung, the larger meshes being filled with an interlaced mass, which forms networks of second and third order, and may also be considered as a product of the coagulation of the fibrine. The network itself, where it is stretched between epithelial cells which have been loosened and pressed far from one another, contains only a few solitary pus-corpuscles, and large pieces of it may be found during the first hours entirely free from cells. Finally, as regards the vegetable growths, the outermost layers of the false membrane are found thickly filled with colonies of micrococcus, while in the middle and lower layers there are to be found only isolated specimens, or they may be entirely absent, because by the rapid and free exudation of fibrine the vegetations were lifted away from the subepithelial tissue, and prevented at first from penetrating it freely.

Not only are the first-formed false membranes lifted up by the rapidly succeeding exudations, but their fibres are also thickened by the repeated deposits of fibrine, and bound together into a broad framework of peculiar amyloid lustre. In the deeper layers of the false membranes, those attached to the subepithelial tissue, is found a fine network, while the more superficial ones are constructed of broad, distinct, interlacing

bands. Often, after from twenty-four to forty-eight hours, portions of the upper and deeper layers of meshes are seen to be infiltrated with blood-corpuscles from superficial capillary hemorrhages which have poured blood into the interlaced fibrine. When a new deposit of fibrine takes place after the hemorrhage is ended, the extravasated blood becomes entirely enclosed and encapsulated by the fibrinous exudation.

While these processes go on from the mucous membrane outwards, the collections of micrococcus penetrate the network in bunches and strips, making their way deeper and deeper, and finally reach the subepithelial tissue, unless they have been lifted away from it and turned back by new exudations. And now, as the process advances, new deposits of fibrine continue to take place, and the false membranes increase in all their dimensions, until death occurs, or cure by the gradual abatement of each exudation takes place. In both cases the false membrane retains its construction unaltered. The ordinarily rapid and extensive loosening which now follows is generally due to this, that the last fine fibrinous fibres of the under layers, which still extend a certain distance into the subepithelial tissue, are not only not strengthened by new deposits of fibrine, but are loosened and floated off, partly by new formation of pus and cells, and partly by a free secretion of mucus from the enlarged glands.

These cases differ anatomically and physiologically from those in which the more or less abundant exudation of fibrine suddenly or gradually ceases, and a slow healing process begins. To the gradual abatement of the fibrinous secretion, and the formation of a network by its coagulation, succeeds at once an active immigration of pus-corpuscles and young cells into the meshes and framework of the membrane, which has hitherto been almost completely free from cells. The steadily advancing pus-corpuscles make their way to the surface, and finally all the cavities and spaces are so filled with them and the large, nucleated young cells, that they become flattened by mutual pressure and form an impassable line of demarcation against the micrococcus growths. I shall describe this process as the stage of *purulent infiltration* of the fibrinous membrane. The puru-

lent infiltration forms the introduction to a slow wearing away of the false membrane by ulceration. When the production of pus is abundant the diphtheritic membranes increase in thickness, but no longer spread superficially. Broad layers of pus and young cells collect between the surface of the mucous membrane, itself deeply infiltrated by these elements, and the fibrinous networks, separating these from the underlying tissue, and giving to the latter an opportunity for rapid regeneration.

Cavity of the Nose, Larynx, and Air-Passages.—When the diphtheritic process extends from the pharyngeal mucous membrane to the cavity of the nose, the larynx, and the trachea, the structure and texture of the fibrinous membrane, as well as its attachment to the underlying tissue, are modified in consequence of the anatomical peculiarities of this mucous membrane, lined as it is with cylindrical epithelium. The first alterations are perceptible chiefly in the epithelium itself. The great majority of the cells and their nuclei are swollen, their lower ends rounded; not seldom the whole cell appears shortened, or its long diameter is evidently smaller than normal, while the lateral diameter is often considerably increased. When the degeneration is more advanced, the cell shows—generally in the position of the nucleus, which then lies on one side—a vacuole, which may still retain or have already emptied its contents, thus giving to the cell an appearance of having been struck with a punch. In many cells, after the fall of the cilia, the plasmatic contents of the uppermost vesicle are seen to project hemispherically. Two, three, or more vacuoles may form in the epithelium, so that the substance of the cells represents only a thin membrane or group of vesicles. Upon and between these more or less altered cells of vibratile epithelium grow vegetable organisms, broad sheets of micrococcus in colonies, forming bunches and strips as upon the pharyngeal mucous membrane. The fibrinous exudation, which here advances much more rapidly and covers a greater extent of surface than it does upon a membrane covered with pavement epithelium, I have seen, in some favorable cases and when produced experimentally on rabbits, follow two main courses. In the one case the fibrine forced itself through the more or less split and separated epithelium to the surface, and even lay in broad strips upon the

slightly altered cells, forming after its coagulation an extensive, fine-meshed network. According to other observations and in rabbits experimentally inoculated, the liquid was poured out in large quantities between the basement membrane and the epithelium, which was thereby lifted off over a constantly widening space, until finally a thick fibrinous network covered the basement membrane, while the epithelium upon the upper layers was in great part worn away or could be found only at isolated points. Sections through a child's tracheal mucous membrane, where the exudation has lasted several days, and there are thick false membranes, show almost no trace of epithelium. Together with the epithelium the micrococcus growths are lifted off by the exudation, as at the time of the fibrinous effusion upon the pharyngeal mucous membrane, so that the underlying tissue into which they had already partly penetrated remains exempt from any further invasion. The false membrane, which is thus formed and is thickened by constantly repeated exudations, either shows here a network which is almost free from cells and formed of fine meshes or, as is oftener the case, this membrane is broken up by broad cellular layers which give to it an often exquisitely stratified appearance, owing to the fact that each layer of large cells is followed by a layer of fibrine, and this order is repeated many times in the thickness of the membrane. Pus-corpuscles also appear in great number, and hyaline lumps of plasma, which are generally to be seen only shortly after the exudation, and disappear during the subsequent coagulation of the fibrine. The attachment of the false membrane to the underlying basement membrane is formed only by thin fibres which can be broken by a slight mechanical force, and thus this membrane can be easily removed in unbroken strips. The healing process is introduced here also by the abundant immigration of pus-corpuscles and the loosening of the membrane by ulceration, or by softening of the connecting fibres, and the lifting up of larger pieces of membrane by the increased effusion of mucus between them and the tissue, while the destroyed epithelium is gradually replaced by a vigorous cell formation.

Subepithelial Tissue.—Since the simple catarrhal inflammation, which the diphtheritic process causes in a mucous mem-

brane, either gets well in a few days, or in unfavorable cases changes into the more serious forms which end only fatally, we have but seldom the opportunity to follow the pathological changes as they occur in the mucous membrane itself.

In the *croupous form*, in which exudation of fibrine into the mucous membrane occurs through the intensity of the diphtheritic disease, I have often been able to follow the development of the process in the tissue itself. Here, too, the anatomical characteristics of the membrane have the principal modifying influence upon the exudation, and upon the behavior of the membrane itself.

(*a.*) In the *pharyngeal mucous membrane, where the pavement epithelium lies immediately upon the connective tissue of the mucosa*, we see clearly during the first days that the fibrinous network is not only found between the divided epithelial layers, but that its fibres, bands, and flakes stretch down, as Nassiloff demonstrated, deeply into the mucosa and submucosa, and can be easily distinguished by their peculiar lustre from the normal intercellular substance. I have quite often observed, with Nassiloff, fibrinous deposits surrounding the superficial small vessels and capillaries, and giving their walls the appearance as if a zone of fibrine had formed about the vessel. Where the surface of the membrane is interrupted by the excretory duct of a mucous gland, the fibrinous exudation continues in a narrow strip down into it, but has not yet been found in the gland itself. If the duct of a gland becomes closed by this means, the secretion collects in large quantity within it, and if its pressure is sufficiently great the mucus may break through the membrane covering the orifice, and empty itself upon the surface, or it may gradually lift up the membrane and collect between it and the underlying tissue. If the exudation is so thick that neither of these events can occur, the mucus collects in the ducts and acini of the gland, expanding them into the form of cysts; their epithelium loosens, changes its form, and floats about with other round and oval cells in the liquid. In marked cases I found the dividing walls, which separated the cystic acini, broken down, and one large cyst formed, in which the remains of the earlier divisions were easily recognizable in the prominences in the wall.

Micrococci are often found between the single lines of coagulated fibrine in the subepithelial tissue, but to a still greater extent in the deeper layers of the mucous membrane, where, as I first described in 1868, they finally penetrate into and develop in the serous canaliculi and lymphatics. Longitudinal and cross-sections of lymphatic vessels often show them to be entirely filled with the fungus, and only isolated lymph-corpuscles can be recognized among the intruding parasites. In other places the micrococci are found less often and in fewer numbers, or they may be entirely lacking, and this is especially the case in those places where the fibrine has been most freely poured out upon the surface of the mucous membrane and an extensive cell infiltration has already taken place in the tissue. In the first days the subepithelial, and even the deeper tissues, contain only a few cells, which are found singly or in groups between bands of fibrine and the connective tissue, and it is only in the region of the submucosa that pus-corpuscles will be found collected in greater numbers, and penetrating thence gradually towards the upper surface. On the other hand, early capillary hemorrhages occur in the upper and middle layers of the mucous membrane, and the extravasated blood-corpuscles are collected in larger or smaller masses between the coagulated fibrine and the meshes of connective tissue. With the advance of the disease the cellular elements often multiply rapidly. Pus-corpuscle presses against pus-corpuscle, broad layers of free nuclei are pressed forward towards the surface of the mucous membrane and infiltrate great bands of it, so that finally the fibrine disappears and the subepithelial tissue itself is thickly filled up to its surface with nuclei and cellular elements. In serious cases this cell infiltration and growth of nuclei may fill the mucous membrane throughout its entire thickness, and extend far down into the underlying tissue, even to the perimysium of the muscular layers of the tongue, of the œsophagus, and of the muscles of the larynx, and cause an accumulation of cells even in the perichondrium of the cartilage of the larynx and trachea. *Active as this cell infiltration may be, yet the development of the diphtheritic membranes*, even when they are three or four mm. and more in diameter, and appear dirty gray, reddish-gray, and

as if attacked with gangrene, is *never caused by them.* The formation of the membrane by exudation of fibrine precedes the cell infiltration, and large as these rind-like membranes may become, never does granular destruction of the cells occur, nor that superficial necrosis of the mucous membrane (by compression of the capillaries) which, according to the earlier views, represented the first beginnings of the false membrane upon the mucous membrane of the throat. Only in rare cases do we see, in single larger or smaller spots on the mucous membrane, real destruction of tissue, ulceration and gangrene, which, in some cases, is followed by healing and cicatrization.

(*b.*) *The mucous membrane of the cavity of the nose, of the larynx and air-passages, the cylindrical epithelium of which is separated by a basement membrane from the deeper tissue*, shows upon the whole the same behavior in the development of a diphtheritic membrane as does a mucous membrane covered with pavement epithelium; the apparently different alterations are produced only by the presence of a basement membrane as uppermost layer of the subepithelial tissue upon which the false membrane rests. As already described, the fibres attaching the false to the basement membrane are thin and tender, seldom thicker than ordinary elastic fibres, while the thick, stout fibrinous bands, such as often penetrate the tissues of the mucous membrane of the mouth, are not to be seen here. The basement membrane itself is very much swollen and infiltrated with masses of fibrine, and displays the peculiar amyloid lustre which characterizes this substance. By this swelling it may attain more than twice its ordinary thickness, and in places where the papillæ of the mucous membrane are covered by it, the swelling of the basement membrane and the accumulation of fibrine may become so extreme that the papillæ themselves seem to consist of homogeneous masses of fibrine, showing its peculiar lustre, and allowing no further structure to be made out. As the threads of fibrine from the false membrane pass directly into the upper surface of the basement membrane, so also can we see fibrinous coagulations entering its under surface in the form of more or less broad bands and brushes, the fine beginnings of which can generally be followed far down into the tissue of the mucous mem-

brane. As to the collection of cellular elements, cell infiltration, and proliferation of nuclei, the same conditions are seen as in the mouth and pharynx. Fibrine and cell infiltration exist here also in inverse ratio. The first collection of lymph- and pus-corpuscles begins at the lowest borders of the fibrinous deposit, which are themselves generally penetrated by only a few cells; from here, while the secretion of fibrine is going on upon the surface, they advance gradually toward the basement membrane, until finally the tissue of the mucosa is almost entirely filled with collections of cells and nuclei. The mucous glands also show the same pathological changes as do those which lie in the affected portions of other mucous membranes. Between the meshes of connective tissue, in the serous canaliculi and lymphatics of the mucous membrane of the nose, larynx, and trachea, I have also found growths of micrococcus, which, partly in the form of strips and bands, partly in balls and colonies, filled portions of these spaces and canals, while other large portions of the tissue appeared entirely free from the parasite. (Comp. Nassiloff.)

When the disease ends in recovery, the retrograde process of the pathological changes, so far as I have had the opportunity to follow it, is the same in the different mucous membranes. The fibrine is completely removed from the surface of the tissue, the cell accumulations press constantly forward, a part of them pass out of the subepithelial tissue, without being followed by new fibrine, break up the false membrane, and form, after its removal, a thin, more or less adherent purulent layer, which probably disappears again completely in a few days.

Another part of the cells infiltrating the mucosa pass back again into the vascular system through the serous canaliculi and lymphatics, and, if the accumulation of cells has not been too considerable, the mucous membrane recovers entirely by this means its normal condition. But when the infiltration of cells and nuclei has been excessive, as always occurs in the severe forms, the greater part of the large collections of cellular elements remains in the mucous membrane, after the fall of the false membranes and cure of the local process, and undergoes fatty degeneration. Thus I found in two patients,—one of whom died, after the termination of the disease in the mouth, from pneumonia

caused by the introduction of foreign bodies into the lungs; the other, from general paralysis,—the upper layers of all the mucous membranes infiltrated with thick layers of fat granules, which, in the tracheal mucous membrane, extended even to the perichondrium, while in some places a few pus-corpuscles were seen undergoing fatty degeneration and breaking down. Where the epithelium has been destroyed by the diphtheritic process it is restored by the active new formation of young epithelial cells, the development of which I cannot here describe more minutely. Losses of substance in the mucous membrane, generally small and superficial, and caused in the very rare cases in which they occurred by necrosis of the uppermost layers of the tissue infiltrated with micrococcus and fibrine, became filled by cicatricial tissue and healed without causing any marked deformity of the surface of the mucous membrane.

Septic Form.

In its first period of development the septic form appears upon the mucous membranes with the same anatomico-pathological appearances as does the croupal, and develops itself out of that.

A large false membrane is formed and its upper surface is attacked with rapid necrosis; it is composed, according to the nature of the mucous membrane, either of broad fibrinous bands or of a finely interlaced network of threads. Shapeless scales of epithelial fragments, fibrinous bands, degenerated pus-corpuscles, nuclei, and detritus form the upper layers, and are filled with masses of vegetable parasites. Extensive strips and balls of micrococcus in colonies continue to develop in the deeper layers, and form, by pressure against the fibrinous bands, as I have already elsewhere described, large alveoli, in which the micrococcus cells lie buried in united glutinous masses. Further down we find the fungus generally in nests, irregular lines, and single strips; but even in the lowest layers large balls of the fungus may be found. Proportionably to the necrosis, the extensive decomposition and the putrefaction, large quantities of the different varieties of bacteria appear, especially bacterium termo,

with fewer specimens of bacterium lineola, spirillum undula, spir. tenue, etc. ; these accumulate upon the surface and in the upper layers of the false membrane, while the micrococcus penetrates the deeper layers. Moreover, the membrane, which is of a dirty gray, dark-brown color, is infiltrated in broad streaks by blood-corpuscles from the always frequent capillary hemorrhages, while other cellular elements, pus-corpuscles and young cells, are to be found only in small numbers and generally very much altered.

With the constantly increasing accumulation of micrococci in the false membranes, the subepithelial and submucous tissues, in which hitherto the vegetable parasites have been found in only isolated deposits, become filled with the penetrating micrococcus, while all the symptoms of the septic disease are intensified. Of all the mucous membranes, that of the nose is the one in which diphtheria most frequently assumes the septic form (Trousseau, Nassiloff, Eberth, etc.) ; it occurs less often in cases where the mucous membrane of the mouth and pharynx are affected ; and where the larynx and trachea are involved diphtheria ends, especially in adults, with symptoms of septicæmia, while in children the free exudation of fibrine causes death by suffocation before septicæmia can take place.

In the substance of a mucous membrane affected with diphtheria, I have observed that the micrococci first arrange themselves in the tissues in horizontal strips or in single heaps, while numerous minute extravasations of blood occur both on the surface and in the submucous tissue. I have also seen the micrococcus forcing itself deeper in along the striped muscular fibres of the muscles of the palate and pharynx, while fresh and older extravasations of blood were found between the more or less degenerated fasciculi. In severe cases Nassiloff found the mucous membrane of the velum palatinum, septum nasi, and posterior nares filled with a brownish mass, which was composed chiefly of vegetable parasites and lay heaped up in the submucosa. Where the mass of micrococci was small he could see the serous canaliculi of the connective tissue of the mucosa and submucosa filled with it in the form of balls and strips, and when the connective tissue was cut parallel to the fibres the fungus lay in

spindle-shaped bundles, which narrowed and widened again, and were bound fast to similar neighboring ones. As was evident at first sight, the masses of fungus in these cases penetrated into canals in which lymph-corpuscles were also generally present, and which, especially as Nassiloff found varicose enlargements in them, are to be considered lymphatic vessels. Eberth also found the widened serous canaliculi and the adventitia of the vessels filled with micrococci in stellate and spindle-shaped groups and in round masses. Toward the deeper layers of the mucosa the quantity of fungus diminished, while broad layers of pus-corpuscles were collected together, and in them single scattered micrococci could be demonstrated with more or less difficulty. Eberth believes that the first invasion of the fungi, small as it probably is, may cause, by the rapid multiplication of these organisms, the characteristic necroses of diphtheria.

But not only can the mucosa and submucosa be penetrated by the micrococcus growths, but also the firmer tissues, cartilage and bone, may be attacked finally by the destructive influence of the vegetable parasites. Thus Nassiloff found, in a case of diphtheria of the septum nasi in a child, the vomer stripped of mucous membrane and periosteum, and its surface rough and eaten away. A horizontal section showed the Haversian canals much widened, with irregular spherical dilatations of their walls, and filled with micrococci partly scattered and partly collected in heaps and balls, while between them lay coarse granules and round cells with indistinct outlines. The dilatations of the Haversian canals are identical in form with the well known carious cavities of Howship, with only this difference, that in caries the dilatations are filled with granulation cells, but in this case with fungus. Similar observations were made by Eberth on an ox, the mucous membrane of whose nose was covered with a dirty-gray false membrane (four mm. thick), which was composed principally of fungus and pus-corpuscles. In the substance of the mucous membrane itself lay young cells and fungus thickly crowded together, and in many places the cartilage itself of the nose was penetrated by numerous scattered micrococci.

When the diphtheritic process has once reached such a height, the patient soon succumbs to the septic poisoning, without the occurrence of further reactionary appearances upon the mucous membrane. When, according to my observations, a cure follows, in less severe cases, it is introduced by extensive demarcating ulceration. Should loss of substance follow the loosening and removal of the diphtheritic products, it is repaired by cicatricial tissue.

Gangrene.

When diphtheria of the mucous membrane ends finally in gangrene, the anatomico-pathological changes pass more or less suddenly, and with excessive increase, into those of complete dissolution and necrosis. Enormous growths of micrococcus and rapidly developing putrefactive bacteria (Bact. termo) in the fibrinous membrane, in the mucosa and submucosa, as well as widespread infiltration of fibrine, and collection of cells and nuclei, produce gangrene of the tissue, partly by the intensity of the destructive processes, and in part mechanically by pressure and arrest of nutrition. No longer does a discolored, dark, blood-stained, and foul-smelling exudation cover a still well-preserved mucous membrane, but false membrane, mucosa and submucosa form together one semi-liquid, discolored, dark pulp, or a darkish wormwood-like, broken-down mass, or a dark, more firmly attached slough, from which the intense peculiar odor of gangrene is spread. When gangrene appears it may first destroy circumscribed portions of the tonsils, soft palate, mucous membrane of the lips or cheeks, and remain limited to these, or it may be diffused from the beginning over all these tissues, or later in its course it may pass beyond the previous limits. The tissues surrounding the gangrenous spots are at first filled with micrococcus growths, fibrinous and cell infiltration, but later are soaked and stained with a reddish or discolored and ichorous liquid (comp. Gang. of cavity of mouth and pharynx). More accurate microscopical investigations have not yet been made, for the termination by gangrene is very seldom seen in our epidemics.

Organs of the Thorax.

Bronchi.—When diphtheria and fibrinous exudation attack the bronchi the process never spreads, either in children or in adults, to all the bronchi, nor is it everywhere equally intense; even in cases where the principal bronchi contain thick false membranes, which can be followed for a considerable distance as solid stringy coagulations, large branches are still found in both lungs free and pervious.

As may be ascertained by a physical examination, the bronchi which run forward from the root of the lung, that is, in the anterior portions of the upper and middle lobes of the right and of the upper lobe of the left lung, are much less covered with fibrinous exudation than those branches of the air-passages which run in a vertical direction, either upwards or downwards (Bartels); these either remain in great part entirely free or are covered, for a distance of, at the most, only a few lines from the point of division of the principal bronchus, with a skin-like false membrane which still allows free passage to the air. Hence the peripheral portions of the anterior bronchi are often quite symmetrically and cylindrically dilated, and thereby is lost that regular reduction in the size of the air-passages which is normally seen near the periphery; at the same time the walls of the bronchi appear excessively thin, pale, and transparent, so that the structure of the lung tissue can be discerned through the delicate walls of the bronchi.

When the bronchial branches, which divide upwards and downwards in the posterior portions of the lung, are attacked by the disease, they too are affected in different degrees, and the principal seat of the fibrinous exudation is almost without exception in the descending bronchi of the posterior portions of the lower lobe, while those which run upwards and backwards in the upper lobe are covered for only a very short distance with the false membrane, and are sometimes found entirely free. Finally, according to Bartels' observations and my own, the influence of existing pleuritic adhesions upon the spread of the process in the bronchi is unmistakable, the fibrinous exudation

being always firmer and more extensive in the bronchi of an adherent lung than in one that is not adherent.

Lungs and Pleura.

The alterations which the tissue of the lung itself undergoes in consequence of the diphtheritic process are in part to be considered as secondary results of the fibrinous exudation in the bronchi, and therefore dependent upon their greater or less permeability to the air, both in children and adults, and in part are caused by the extension of the process to the lung itself.

1. In cases of the first sort, in which death is caused by suffocation, the lungs generally are smaller than usual, so that the diaphragm rises as high as the cartilage of the fourth rib, and the pericardium is less covered than usual by the lung. It will be often found that, when the thorax is opened, the lungs collapse either very little or not at all.

The anterior surfaces of the lungs, especially in their upper portions, are, as a rule, pale, bloodless and emphysematous, and the capillaries are dilated; only in exceptional cases were the anterior borders of the upper and middle lobes of the right lung and the tongue-shaped process of the upper lobe of the left one, which lies upon the pericardium, found red with blood, empty of air and collapsed. In most cases more or less numerous air-bubbles are found under the pleural coat of the lung, a consequence of numerous ruptures of the alveoli. When tracheotomy has been performed and the patient has survived for a longer time, this subpleural emphysema is of much more frequent occurrence. The air which has escaped under the pleura, by the rupture of the alveoli and substance of the lung, can spread backwards under this envelope to the root of the lung, penetrate into the loose cellular tissue between the folds of the mediastinum, and lead to extensive emphysema of the subcutaneous cellular tissue of the body (Bartels).

In contrast with the anterior surfaces of the lung, its posterior portions, especially those of the lower lobe, but ordinarily also those of the upper, are very full of blood; and it often happens that some of the lobules, and even large sections of the posterior

portions, both of the lower and upper lobes of both sides, are found completely empty of air. These empty portions are of a dark, bluish-red color. Their surface lies below the level of those portions of the lung which still contain air; they can easily again be completely inflated through a tube placed in the bronchi, and they then assume a scarlet color. Here, too, we have to deal only with collapsed portions of lung (Bartels). But when the air has been driven out of larger sections of the posterior portions of the lung, other alterations will be found to have already taken place in them. The substance of the lung will be found to be more compact, and there will be spots which seem quite hard and firm to the touch, which upon section project above the surrounding surface, and which are generally colored a deeper brown, so that the surface of section of such a lung has a marbled appearance. In such lungs, as Bartels has shown, the regularly granular surface of section is not found as it is in the croupous form; this infiltration of the substance of the lung is not due, therefore, to the spreading of the fibrinous exudation upon the alveoli, but these appearances, as Colberg first demonstrated microscopically, are identical with those which we are accustomed to describe as catarrhal pneumonia.

2. When the diphtheritic process extends to the tissue of the lung itself, or leads to a fatal termination with symptoms of general poisoning, without having caused fibrinous exudation in the finest bronchi and alveoli, the lung shows more or less numerous and extensive extravasations of blood, which are either scattered through the tissue itself, especially in the posterior portions of the lung, or lie under the pleural coat of these parts. These extravasations vary from an ecchymosis the size of a pea to an infarction as large as a walnut, and I have several times seen infarctions as large as a hen's egg in adults in whom the exudation of fibrine had spread only a very short distance into the two large bronchi. Bartels saw a large extravasation under the left costal pleura, along the vertebral column.

On microscopical examination of cases in which the fibrinous exudation extended into the finest bronchi I found also in the alveoli fibrinous nets and bands in which more or less pus-corpuscles were enclosed, while in other alveoli they were partly

infiltrated with blood-corpuscles. In other portions of the same lungs the alveoli were thickly filled with large swollen cells. epithelium, or, after free bleeding from the capillaries of the walls, with blood-corpuscles. Micrococcus colonies could also be demonstrated in several alveoli where they had spread between the blood-corpuscles and the young cells. The tissue itself of the lung was thickly infiltrated with pus-corpuscles, but yet in every case the individual capillaries which wound about the walls of the alveoli could be seen filled with blood-corpuscles. Where the tissue of the lung appeared filled with larger or smaller hemorrhagic infarctions and inflamed, the accumulation of cells and nuclei had reached so high a degree that cell was pressed so closely against cell, nucleus against nucleus, as to present that appearance of multiplication of cells and nuclei which is seen in mucous membranes affected with diphtheria. The alveoli also were often so thickly filled with cells and nuclei that the latter appeared to form a homogeneous mass within them I found also broad fibrinous frameworks with enclosed cells and blood-corpuscles or only coagula within them. Together with the larger hemorrhages visible to the naked eye, appear numerous microscopical ones between the widespread growths of cells and nuclei, so that the thickly crowded blood-corpuscles assume an irregular polyhedral form from reciprocal pressure, and present a peculiar honeycomb-like appearance, such as is seen in extravasations in a diphtheritically affected mucosa.

Heart.—The subpleural emphysema, which may develop to a greater or less degree when the fibrinous exudation is very extended, whether tracheotomy has preceded the death or not, can, as we have seen, penetrate into the loose cellular tissue between the folds of the mediastinum, and cause, as consequence of this simple physical process, an emphysema of the pericardium.

The extent to which this may go is shown by an observation of Bartels, who heard in a boy in whom violent suffocative attacks occurred, a few days after tracheotomy had been performed, together with the distinct and clear heart-sounds, a very loud and quite peculiar friction-murmur, so that he thought there was an abundant fibrinous exudation within the pericar-

dium, whereas the autopsy showed it was completely surrounded by inflated meshes of cellular tissue.

When death has occurred with symptoms of general blood-poisoning, or when this latter has complicated laryngeal and bronchial lesions which have caused death, we find small and large hemorrhages and ecchymoses both in the parietal and visceral layers of the pericardium, and also under it in the substance of the muscle of the heart. The extravasations which I have seen here varied in size from that of a pin's head to that of a pea, and were generally scattered, rarely crowded in close groups. Buhl found such spots of blood upon the outer surface of the right ventricle, also in the endocardium of the left and right ventricles, with accumulations of nuclei, especially under the pericardium, the appearances being similar to what he found in the mucous membrane of the throat.[1]

The muscular substance of the heart itself, in cases in which the disease has spread principally in the air-passages, and death by suffocation has ensued, appears entirely unaltered, as well in color and texture as in its histological elements. But if on the other hand the diphtheritic process has attacked the whole organism, and the patients succumb to general poisoning and septicæmia, then the muscles of the heart are more or less broken by extravasations of blood, are friable, and show in places accumulations of cells and nuclei between their fibres. When the general disease lasts long and is very intense, and especially in cases in which death is caused suddenly by paralysis of the heart, the muscle appears pale, soft, friable, broken by extravasations of blood, and on microscopical examination most of its fibres are seen to be already in an advanced stage of fatty degeneration. The same appearances of advanced fatty degeneration, with extravasations of blood of former and more recent date, I saw in a case of diphtheritic ataxia in which death was caused

[1] Extensive growths of fungus upon the valves and endocardial deposits have been repeatedly found of late. Compare: *Bouchut*, Endo- and Myocarditis in Diph. (Gaz. des Hôp. 117, 1872). *Heiberg*, A Case of Endocarditis Ulcerosa Puerperalis with growth of fungus upon the heart; appendix by Prof. Virchow, Virch. Archiv, LVI. 3 S. 415, 1872.—*Heiberg*, Puerp. und pyaem. processe, Leipzig, F. C. W. Vogel, 1873.—*Eberth*, Ueber diphther. Endocarditis, Virch. Archiv, LVII. 2 S. 228, 1873.

by œdema of the lungs about six weeks after the termination of the affection of the mucous membrane.

In the most severe forms of septicæmia and poisoning the blood is slightly coagulable, sticky, brown or rather livid, and soils the fingers like sepia; the arteries are not empty, but often contain as much as the veins (Millard). In the blood of diphtheritic patients and inoculated rabbits Hueter and I have found numerous micrococci.

Abdominal Organs.

Pathological alterations of the abdominal organs are, with the exception of the kidneys, to be seen in only rare cases of widespread general infection. As a rule, these organs, even when the patients succumb finally to general poisoning, are found but slightly changed, or remain entirely normal, especially in children who have died from rapidly occurring fibrinous exudation in the air-passages.

The *peritoneal covering of the liver* shows, in rare cases, scattered or numerous capillary hemorrhages, such as have been already noticed upon the pleural covering of the lungs and upon the pericardium. The alterations in the parenchyma of the liver, when they are found, are to be ascribed only in the rarest cases to the diphtheritic process alone; and even a decided fatty degeneration of the same, especially in adults, is to be always judged with a certain degree of precaution. When the disease lasts a long time, abnormal multiplication of nuclei and accumulation of lymphoid cells may occur in the liver; on the other hand, hemorrhages in the parenchyma are more rarely seen. The spleen also does not always participate in the greater anatomico-pathological changes. In some cases I found it enlarged, the capsule stretched and covered with extravasations of blood; the parenchyma dark cherry-red, soft and easily torn; the Malpighian bodies indistinct, or in other cases enlarged. Buhl has also repeatedly demonstrated multiplication of nuclei in the spleen. In cases, however, in which the diphtheria ended with intense general poisoning, I found the spleen only slightly enlarged and its parenchyma of normal texture and color.

Direct infection of the stomach can take place in two ways, either by the swallowing of diphtheritic masses, or by the extension of the affection of the mucous membrane from the pharynx to the œsophagus, and from this to the stomach. We may thus see the products of diphtheritic inflammation again appear upon the mucous membrane of the stomach, exudation and coagulation of fibrine, formation of ulcers and sloughs; while the subepithelial and submu coustissues are broken by capillary hemorrhages and infiltrated by cellular growths, which Buhl found especially around the bottoms of the tubular glands, and between them.

When, on the other hand, the affection of the stomach is to be considered as secondary, in consequence of the general infection, cell infiltration and hemorrhage likewise appear again in its mucous membrane; and these clots of blood, from a pin's head to a pea in size, can appear in such quantities and so near one another, that whole strips of the mucous membrane of the stomach are colored red.

The same hemorrhages, as symptoms of secondary affection, have also been observed in the mucous membrane of the intestine, but fewer in number and less in extent; also in the mucous membrane of the bladder, and Buhl found, on opening the body of a person who had died of diphtheria, such extensive hemorrhages from the great omentum, that a considerable quantity of free blood had collected in the peritoneal cavity.

Kidneys.—The kidneys are attacked by the diphtheritic process at the beginning, and quite often with the same intensity as is the mucous membrane. The albuminuria, which often appears after a few hours, furnishes at the bedside an accurate diagnosis of the affection of the kidneys. This symptom is an especially important aid in recognizing diphtheria and in estimating its severity. The primarily affected mucous membrane, and the forthwith infected kidneys appear to stand in a sympathetic connection, which is formed by the currents of the juices and of the blood, through the absorption and secretion of the infectious materials. Everywhere are found in such cases the signs of parenchymatous inflammation of the kidneys, with hemorrhages and growths of micrococcus.

In cases in which the patients, particularly children, die by suffocation, the kidneys are generally but slightly swollen, more or less hyperæmic, and the cortical substance is perhaps somewhat more deeply colored and sharply limited from the medullary substance. In general poisoning, on the other hand, when death has likewise occurred at the end of a few days, the kidneys are quite often swollen to a considerable degree, lividly hyperæmic, the cortex and medulla deeply reddened and but slightly distinguished from each other in coloration. The Malpighian bodies also in such cases can no longer be distinctly recognized, and in their places often appear numerous points of blood, which at times are confined chiefly to the parenchyma, though often they are found in greatest numbers near the surface and under the capsule, in which latter place infarctions as large as a pea are sometimes found. Between the slight and extensive alterations of the kidneys, different intermediate degrees are also to be observed in different cases. The greatest alterations are found in the uriniferous tubes and the Malpighian tufts. In the lightest forms of the affection the epithelial cells appear swollen and enlarged, their contents granular and opaque, and on section they are seen to fill the canals almost completely. In other cases the cells lie rolled together and loosened from the wall, like solid cylinders in the middle of the canal, and correspond completely with the epithelial casts which are found in the course of the albuminuria of these patients. Moreover, they resemble exactly those cylinders composed of degenerated epithelium which I repeatedly had the opportunity to observe in the uriniferous tubes of rabbits that had been experimentally infected. Of the formation of hyaline casts and their occurrence,—although they can be found so often in the urine in severe cases,—we have as yet no detailed descriptions, since we seldom have the opportunity in an autopsy to meet with this stage of alteration of the kidneys. Between these more or less altered uriniferous tubes are found numerous others, the calibre of which is filled with blood-corpuscles, so that they might be mistaken at the first glance for veins. The source of the bleeding is generally to be sought in the Malpighian tufts, from which the blood has poured out into the tubes. Rupture of the vessels happens exceedingly often in the Malpi-

ghian tufts themselves, and the capsule then is more or less filled by a clot of blood which presses the vascular loops toward one or the other side; or if the bleeding has been central, near the point where the arteriole enters the capsule, it lies like a wedge between the loops, pressing them apart toward each side. In the interstitial tissue and the connective tissue surrounding the Malpighian tufts it is not unusual to find numerous lymphoid bodies, often pressed closely together, and in many cases surrounding, in thick rows, the capsular membrane of such a tuft. I have never noticed that these lymphoid cells penetrated into the capsule itself.

Besides these alterations we can also find in such kidneys numerous micrococci, and even extensive growths of them, both in the uriniferous tubes and in the Malpighian tufts; the epithelial cylinders also are not seldom covered with them in strips and heaps throughout their whole length. These appearances also are found in experimental infection of rabbits, if the animals succumb only after several days to general poisoning. In one case Eberth saw the uriniferous tubes of the pyramid often completely plugged for a short distance with micrococci, or containing small colonies of them. Also in the stroma, which just here was somewhat thickened, were found oblong heaps of these parasites, which were often the centre of small cell multiplications and abscesses. Examination of the cortex soon revealed the source of the kidney parasites, for the vessels of many glomeruli either often contained small micrococcus balls or were most elegantly and completely injected with them. About those glomeruli which contained the most parasites was found a not inconsiderable accumulation of young cells. Virchow found these deposits of vegetable organisms in the uriniferous tubes of women who had died of puerperal fever, and considers these diphtheritic masses certainly as parasites.

Finally, as to the connection of the disease with the local and general infection, we see in cases of small diphtheritic patches, as in those of widely extended, tough false membranes in the air-passages, both active and slight participation of the kidneys in the pathological process without any characteristic difference. But, on the other hand, when general poisoning and the septic

form are prominent, the kidneys do not share in the alterations only to a degree which corresponds with that of the other organs and tissues, but they are found in the majority of cases to be the most intensely affected of all.

Brain and Spinal Cord.

In its slow but sure progress the destructive process of general infection reaches the central organs, the brain and spinal cord. That up to the present time we should possess but few observations of the pathological changes in these organs is due to this fact, that the great majority of patients die at an early stage by suffocation when the air-passages are affected, or succumb to blood-poisoning before visible alterations have yet occurred in them. As earliest form of the change, I found extensive venous hyperæmia both in the vascular linings, and in the substance itself of the brain and spinal cord. At the same time, I observed in some cases small capillary hemorrhages scarcely as large as a pea, generally scattered, or in groups of two or three, in the white medullary matter of the brain, while in the cortical layer and in the central parts no extravasation was found. The spinal cord also, which I examined in two cases, showed no recognizable macroscopical or microscopical alterations.

When, however, the affection has risen to the greatest intensity, we can see at once, on opening the skull, isolated hemorrhages in the dura mater, and, after its removal, generally in still greater number and extent in the pia mater, both in the portion covering the surface of the brain and also in the folds which dip down between the convolutions. These clots extend also to quite a depth into the cortical substance of the brain, and may, as Buhl has observed, reach the size of a pea. Hemorrhages may occur also in the other portions of the brain, in the medullary matter, in the commissures and ventricles, also in the optic thalami and corpora striata, the crura, the pons, and in the cerebellum (Buhl), and these ruptures of vessels can be traced along the medulla oblongata and spinal cord. The substance of the brain is thereby softened, especially in the neighborhood of the clots, which are surrounded by a reddish or yellowish zone, while the

spinal cord generally maintains a firmer consistence. Finally, in the spinal nerves of both sides, at the point of junction of their anterior and posterior roots, and including the intervertebral ganglionary swelling upon the latter, Buhl found in one case this remarkable appearance: they were almost doubled in thickness, dark red on account of extravasation of blood, and in parts yellow and softened. This appearance was most marked in the lumbar nerves, somewhat less so in the roots of the nerves of the upper cervical region, and least in the nerves distributed to the back. Microscopical examination of these parts showed also that the sheaths of the nerves, and here and there also the strips of connective tissue running between the bundles of nerve-fibres and the ganglion-cells of the sensitive roots, were filled with accumulations of cells and nuclei.

Other Organs and Tissues.

Lymphatic Glands.—A pathological lesion, to which much reference has been already made, consists in the inflammation and swelling of the lymphatic glands, whose vasa afferentia arise in the diphtheritically affected portions of mucous membranes, or which are connected with glands already involved. (Comp. Sympt.) The periglandular and subcutaneous cellular tissue is, in consequence, œdematously swollen and feels doughy, or, if there is much infiltration, hard like a board. If such swollen glandular masses are divided on the cadaver, the subcutaneous connective tissue is found in part œdematously infiltrated, in part filled with quantities of lymphoid cell-nuclei and pus-corpuscles, and not seldom are there numerous capillary hemorrhages varying in size from that of a hemp-seed to that of a bean, both in this and in the periglandular cellular tissue. In some cases I found a large part, even more than the half, of a gland which lay in a hemorrhagic cavity, surrounded by considerable layers of extravasated blood. The gland itself had acquired a greater or less additional volume by hyperplasia of its cellular elements, while its stroma of connective tissue showed no thickening worthy of mention. I could almost always find in the glands micrococci in considerable number.

Of importance and especial bearing in relation to the etiology and pathogenesis of diphtheria are, finally, the contents of the vasa afferentia and connective tissue surrounding the nearest cervical glands, as observed by me in a case which I published several years ago. I found in the lymphatic vessels, and in the network surrounding their glands, the vegetable parasites collected in considerable quantity. Many lymphatic vessels appeared to be entirely plugged by them for long distances; in other places I saw smaller masses scattered along the vessels, and again in others the micrococci occupied, in greater or less quantities, different branches of the network of lymphatics, so that the object presented, on account of this distribution of the micrococci, almost the appearance of an unsuccessful injection of the vessels. I found also between the different meshes of the connective tissue, and between the fat-cells, larger or smaller heaps of micrococci.

Notable anatomico-pathological alterations have as yet been but seldom found in the muscles, although very varied disturbances of the muscular system are produced directly by the diphtheritic process, as by no other infectious disease. In the majority of the cases, to decide according to scanty direct information, the muscular fibres seem to have shown no variations from the normal character.

The degree of destruction of the muscular tissue produced by diphtheritic infection can be seen, as I have shown, by experimental transmission of the disease to animals, by inoculation under the skin and into the muscular tissue. In such cases, in distant groups of muscles, whole fibres can be found destroyed, with partial disappearance of the cross-markings and crumbling into separate flakes and lumps; while again, in other parts, alterations of the muscular fibres will be observed, which bear all the signs of the waxy degeneration first described by Zenker. The capillaries woven about the muscular tissue are torn in many places, and the thickly crowded capillary hemorrhages may give the affected muscle of the rabbit an entirely reddish brown, even black appearance. Even between the muscular fasciculi, in the lymphatic spaces and serous canaliculi of the interstitial connective tissue, are found in these inoculated

animals extensive growths of micrococcus, which, having penetrated into them, fill all the spaces and meshes of the lymphatic network about the muscular fasciculi by their rapid multiplication, so that thereby in many regions a fine representation of a partial injection is given.

Hitherto fatty degeneration and granular cloudiness of the muscular fibres have been most frequently found, and in a case of Buhl's, a boy, eight years old, who died in the fourth week of the disease, these alterations extended over the muscles of the body and heart, while at the same time fatty degeneration of the other organs was also found. The accumulation of nuclei and lymphoid cells, reaching far down into the subepithelial tissues of the mucous membranes of the mouth and pharynx, extends not seldom also into the underlying muscles, and I found these cells in great numbers between the fibres of the muscles of the palate and pharynx, also in the muscles of the larynx, the thyro-arytæn. internus and the transversus, and in the fasciculi of the arytæno-epiglottidæus.

Capillary hemorrhages, in part visible to the naked eye, in part microscopical, appear also in the muscles as in other organs, and especially in the upper layers adjoining the mucosa, while the deeper ones are generally found free from them, except in the rarest forms of septic diphtheria. In two cases, once in the palatal muscles of a man forty years old, and again in the laryngeal muscles of a girl thirteen years old, who died on the ninth and thirteenth days of the disease, I found among other apparently normal fibres, many which had undergone complete waxy degeneration, and were broken up into larger and smaller fragments, and partly crumbled. Both between the normal and the degenerated fibres lay numerous nuclei and lymphoid cells; the nuclei of the sarcolemma were also everywhere enlarged and proliferating.

Of the group of diphtheritic wounds, the more detailed description of which we must leave to the surgical text-books, we can only consider in the present article the infection of a wound of the trachea, where a tracheal fistula has been established to prevent death by suffocation. As first symptom of such a diphtheritic process, developing here, I have observed

already on the second day after the performance of tracheotomy, an extraordinary multiplication, in the secretion from the wound, of micrococci which were not very numerous on the preceding days. In addition to the large cells containing much plasma, the nuclei of which were generally larger than a pus-corpuscle, and other cells containing blood-corpuscles, the secretion of the wound was found to contain these parasites in great numbers, though not grouped together in glutinous masses and colonies. On the third day, when the edges of the wound already presented a discolored appearance, the majority of the cellular elements were covered thickly with micrococci, and had in part taken them into their interior. On the fourth day,—the day on which the child succumbed to the disease,—the edges of the wound were covered with a gray, discolored, foul-smelling exudation, which at the same time extended into the trachea, and was in part coughed out through the canula; at this time, however, the cellular elements, which were present in it before, had almost disappeared, and only scattered nuclei and a few relatively well-preserved cells, thickly covered with fungus, were found. But, on the other hand, the micrococcus was present in all its forms, and the glutinous masses and colonies formed large adherent patches in which detritus, fat granules, and shapeless fragments were found. Eberth observed, on the surfaces of the wound, from twenty-four to forty-eight hours after the operation, the characteristic, dirty, yellowish-gray, dry, diphtheritic coat, which could not be removed without injury to the latter. On the section of fresh, diphtheritic wounds of the trachea there appeared a distinct layer, recognizable as a gray edge, which was nothing else than the surface of the wound infiltrated with micrococcus. When the cut was carried through the connective tissue Eberth found next to the surface of the wound only a slight growth of cells, but deeper an abundant one. The fundamental substance is in such cases swollen and softened, but the elastic fibres are unchanged, and in a measure form the framework of the diphtheritic skin like covering, which is composed of some fibrinous exudation, but principally of connective tissue, filled with scattered micrococci, assembled in small colonies. Although in such cases the

mycosis is generally very superficial, yet in many places the micrococcus is seen penetrating deeply between the bundles of connective tissue and muscles.

Sequelæ.

Brain, Spinal Cord, and Peripheral Nervous System.

It has needed many years for us to give up pure hypothesis in the explanation of diphtheritic paralyses, and to let fall the ungrounded opinions of a paralysis due to the specific action of the diphtheritic poison upon the nervous system, like lead poisoning, of one due to an idiomuscular affection, or of one due to anæmia or defective assimilation of the blood. As we have already mentioned, Buhl found in one case that the spinal nerves were thickened at the roots, that hemorrhages had taken place, and that the sheaths of the nerves, and here and there also the strips of connective tissue running between the bundles of nerve-fibres and the ganglion-cells of the sensitive roots, were filled with lymphoid nuclei and cells. That such infiltrations are also present in the further peripheral course of the nerves is not improbable, still no direct observations upon this point have been published.

Buhl thinks that the scantier and smaller localized accumulations of nuclei and cells, which are produced in the lower grades of infection, are absorbed again, after undergoing fatty degeneration, without having made themselves particularly noticeable, but that the more numerous and larger collections of the higher grades are followed by a perceptible thickening of the connective tissue. When these growths proceed to a further development into connective tissue, the more or less marked distention of the fresh connective tissue first disappears, the tissue contracts, and consequently embraces circularly the sheaths of the nerves and the bundles contained therein. Finally, it must be borne in mind that as a result of absorption the thickest and most contracted cicatrix becomes later again looser, more pliant and more movable, that is, the connective tissue becomes normal; consequently, according to Buhl, the nerve symptoms appear when

the constricting effect of the thickening of the connective tissue begins, they persist while it lasts, and disappear finally when the thickening diminishes.

That in the origin of diphtheritic paralysis we have to deal not only with a retrogressive and transformative process of pathological products, caused by the disease, but also with an active, still-enduring action of the disease in the brain, spinal cord, and peripherical nerves, I had the opportunity to observe in a case of diphtheritic ataxia. While the diphtheritic products were undergoing further softening, and the successive degenerative processes appeared in the organs lying outside of the cavity of the skull and vertebral column, the destructive process indicating the general infection continued with undiminished activity in these innermost cavities.

Whole muscles were atrophied to a degree which I had hitherto seen only in the last stage of progressive muscular atrophy, and the greater part of the still preserved muscular fibres were undergoing fatty degeneration, and only here and there among them could be found fibres that were apparently still healthy. While the pharyngeal mucous membrane showed neither scars nor losses of substance, nor any other changes beyond an extreme anæmia, the mucous membrane of the larynx and trachea was rather pale and gray in color, slightly swollen, and covered with numerous grayish-opaque nodules, as large as a millet-seed.[1] These grayish nodules were composed of large masses of lymphoid cells and nuclei, which in some places lifted the vibratile epithelium in corresponding strips away from the thin and striped-looking basement membrane, in others were crowded between the epithelial cells, and in others again lay upon them. In the subepithelial and submucous tissue there were found, together with the numerous crowds of young cells and nuclei, broad and extended layers of larger and smaller granules, and drops of fat, and isolated, broken-down cells undergoing fatty degeneration. The upper lobes of the lungs were pale, empty of blood, and contained air; both the lower ones were œdematous without inflammatory infiltration or thickening. In the tissue

[1] Comp. Dr. *M. Röth*, of Greifswald, Lymphatic Growths after Diphtheritis. Virch. Archiv, LIV. 1 and 2, p. 254. 1871.

of the lung itself fat granules and cells in fatty degeneration could be seen. The muscle of the heart was withered, friable, and all its fibres in a state of fatty degeneration. In the liver and kidneys, likewise, were found the signs of a high degree of fatty degeneration, both in the hepatic cells and epithelium of the uriniferous tubes, and in the interstitial tissue, in which numerous degenerated cells and nuclei were embedded. Finally, the spleen appeared soft, and its capsule was slightly stretched, while in the stomach and intestine no alterations worth mentioning were noted.

But, on the other hand, the opening of the skull and vertebral column disclosed a picture which corresponded exactly with that which was presented only in the highest forms of general infection, and during its most acute course in the affected organs and tissues.

Prominent above all was the hyperæmia and the extravasations which covered the exposed organs. When the numerous points were examined more closely, it was found that the extravasated blood appeared to be in part fresh, belonging to hemorrhages that had occurred during the last days, and in part differently altered, even changed into crumbling rust-colored masses. The same conditions appeared on examination of the substance of the brain and spinal cord, and the nerves issuing from it. Here then were the evidences of unintermitted ruptures of the vessels, discoverable, four weeks after these hemorrhages had ceased, in the primarily affected mucous membranes and other tissues, and while their traces could still scarcely be demonstrated microscopically.

The skull-cap and meninges of the brain were exceptionally hyperæmic, their veins distended with blood, the membranes of the brain slightly clouded, and the sulci between the convolutions somewhat diminished. The substance of the brain was compact, congested, broken by capillary apoplexies, and a clot as large as a cherry-pit lay in front and on the inner side of the left optic thalamus. The ventricles were not distended, and contained only a small amount of bloody serum; on the other hand, the choroid plexus was filled with blood. The cerebellum also was congested, but showed fewer apoplexies. The medulla

oblongata, the olivary bodies, the pons, the corpora quadrigemina, the lateral portions of the cerebellum, and the fissures of Sylvius were completely lined with clots from smaller hemorrhages, and with vessels distended with blood.

The meninges of the spinal cord were still more affected ; in some parts there were fresh extravasations, in others the traces of earlier ones covered broad strips, especially upon the right side where the roots of the nerves were entirely enveloped in coagula. Microscopical examination of the spinal cord showed a considerable increase of nuclei in the gray matter which to the naked eye appeared free from hemorrhages and softened spots. The infiltration of nuclei extended rather into the anterior horns of the gray matter, which was most richly filled with microscopical hemorrhages, and the nuclei themselves were undergoing fatty degeneration. Most of the nuclei were thickly infiltrated with granules of fat ; the membrane was exceedingly tender and was wanting in some parts ; the granules were still in simple aggregations, or had run together into larger drops, until they finally formed great spherical masses of fat, which enveloped like a sheath the vessels and nerve.fibres, and also the roots of the nerves in the anterior and posterior columns of the cord, and assumed many grotesque, stalactite-like forms. In the capillaries of the cord I found fatty degeneration, and in the adventitia of the small veins a marked increase of nuclei. Most remarkable was an exudation, rich in cells, upon the vibratile epithelium of the central canal of the spinal cord ; this exudation filled its calibre almost completely, and extended with slight interruptions throughout almost its entire length. Under this vibratile epithelium was a free infiltration of nuclei, which penetrated, especially on the right and left, far into the neighboring tissue.

Similar alterations in the spinal cord, which correspond exactly with a disseminated myelitis, were observed and described as such after small-pox by Lewinson.

Finally, it is of importance that in this case a large quantity of the smallest variety of micrococcus was found as well in the blood and hemorrhages of the membranes of the brain and spinal cord, as in the tissues.

According to the results of these investigations, we shall then have to explain the functional disturbances in the different muscles, from simple paresis of individual groups up to complete paralysis of the same, or of the whole muscular system, by the alterations first in the muscle itself, then in the peripheral nervous system, and finally in the central organs, brain and spinal cord.

DIAGNOSIS.

Distinctive as are the symptoms with which diphtheria appears in its clearly marked forms, yet it is quite often difficult in individual cases to decide if diphtheritic disease be present. In general, one is less likely to err in the diagnosis during an epidemic of the disease, than in sporadic cases, in which a definite distinction is often extraordinarily difficult.

In the whole list of subjective symptoms there is no single one which would be completely indicative and conclusive in the diagnosis; and just as little possible would it be to give a complete and well-defined picture of a diphtheritic attack which would correctly represent every case at all times. A circumspect weighing of all the diagnostic points, a careful review of the general symptoms, a close ocular inspection and physical examination, a microscopical analysis of the patches adhering to the mucous membranes, are essential to form a conclusive opinion in doubtful cases.

Catarrhal Form.

The catarrhal form of diphtheria is generally recognized with most difficulty because of its apparently insignificant symptoms, and other diseases are most frequently taken for this form. Its further development and passage into a more serious form removes all doubt after a time, and justifies the first diagnosis.

Catarrhal anginæ are most frequently looked upon as diphtheritic processes; in them a hypersecretion from the tonsils takes place, with moderate redness and swelling. A small part of the secretion is generally forced out of the follicles, as a

yellowish, sticky mass, and forms about the latter a thin layer that can be easily removed with a brush, and in which the different fungus and bacteria forms, leptothrix buccalis, oidium albicans, cryptococcus, etc., develop later. In other cases, slight follicular erosions are formed, and the yellow suppurating base of these little ulcerations can, on superficial observation, be likewise mistaken for a diphtheritic deposit. The borders of the ulcers and the distinct loss of substance, which can almost always be seen, make the diagnosis sufficiently sure, for diphtheria, especially in these lighter forms, never causes such loss of substance, and testimony to the contrary should be accepted only with the greatest reserve.

Aphthæ, also, if they appear upon the mucous membrane of the soft palate, may be mistaken on superficial investigation for diphtheritic products, and this is especially the case if the broken vesicles run together and represent a larger ulcer. A moderately careful examination will enable one to distinguish between these and diphtheritic deposits without difficulty. Even when no new vesicles or nodular elevations appear beside those that are already broken, still there is always present a larger or smaller irregular ulcer, the borders of which are slightly raised and hard, and often bleed easily on pressure, while the base, which is to be found in the mucous or submucous tissue, presents a lardaceous appearance, and likewise often bleeds when touched with some force (Bamberger). When the vesicles filled with yellowish exudation increase rapidly in size and run together before the covering layer of epithelium is broken, the characteristic form produced by the aggregated vesicles can always be correctly recognized.

Croupous and Septic Forms.

When the severe forms of diphtheria appear with violent general symptoms, high fever, great prostration, evident brain symptoms, tumefaction of the spleen, it is possible that the local symptoms may be thereby more or less hidden, and another essentially typhoid process seem to be going on. As a rule, the local symptoms, swelling, exudation, and difficulty of swal-

lowing, are developed to an equally intense degree in these forms of malignant diphtheria of the pharynx, and consequently draw attention to themselves from the first; but there are individual cases in which an extensive exudation may cause pains in the neck that are scarcely noticeable, and the patients, especially when they are not very sensitive, do not mention them, but they and their attendants feel most anxious on account of the severe general symptoms alone, the typhoid fever and the great prostration. A single inspection of the pharnyx will make the diagnosis sure in such cases, and an attentive examination of the patient will, almost without exception, impel to such an inspection.

The diagnosis becomes difficult when the diphtheritic process first develops in places which are not immediately accessible to the eye of the examining physician. If the localization of the diphtheria has taken place primarily in the cavity of the nose, the diagnosis in the majority of cases first becomes possible after the symptoms of nasal diphtheria have been completely developed (vid. supra). Patches upon the posterior portions of the turbinated bones, in the naso-pharyngeal cavity and upon the posterior surface of the soft palate, may be discovered in certain cases with the aid of the rhinoscopic mirror, without regard to the fact that in such cases the whole mucous membrane of the pharynx and of the soft palate is sympathetically affected. In similar manner are processes in the lower portions of the œsophagus, in the entrance to the larynx and in the larynx itself, to be recognized only by means of the laryngoscope.

The diagnosis of this disease from simple croup is attended with certain difficulties. The anatomico-pathological separation of croup and diphtheria, according as a fibrinous exudation lies upon or in the mucous membrane, is no longer possible, since we have seen that in the severest forms of diphtheria, those followed by extensive and long-enduring paralysis, free fibrinous exudations have been formed upon the mucous membrane. Accordingly, if we consider croup an independent form of disease, and do not, as has repeatedly happened since Bretonneau's time, identify it with diphtheria, we must indicate by the name croup only a purely local inflammation of the larynx and mucous membrane,

called forth by different deleterious natural influences, atmospheric relations, etc., in which the degree of inflammatory irritation is so high that there is no longer produced a sero-purulent, but a fibrinous exudation. The clinical distinction between the two diseases will consequently lie in a careful estimate of the general symptoms, the affection of the glands and kidneys, in the non-contagiousness, and partly also in the sporadic appearance of the croupous inflammation. All other diagnostic points are unreliable, and where these are lacking a strict diagnosis may be impossible during the first period of the disease.

When diphtheria is accompanied, as happens in rare cases, by a slight erythema of the neck and breast, it may be mistaken for scarlet fever. Here, too, the local as well as the general symptoms are much more prominent; a bright inflammatory redness spreads over the mucous membrane of the mouth and pharynx, and even of the tongue, and that too in cases in which there has been no formation of false membranes, and only single, small, yellowish patches are visible upon the tonsils, while the fever has already reached an unusual height; violent agitation of the patient, vomiting, headache, delirium, convulsions and stupor appear, as they do only exceptionally in pure diphtheria.

Gangrene.

Gangrenous lesions in the mouth, when they are really present, taken in connection with the characteristic alterations of the affected organs, can hardly be confounded with other diseases; whether or not they are the final symptoms of a diphtheritic process can be known by the simultaneous existence of diphtheritic products, or possibly shown by the anamnesis. (Comp. gang. of mouth and pharynx.) The question oftener is, whether in a case that is unquestionably diphtheritic actual gangrenous destruction of the soft parts has occurred or not. If any doubt should still exist after an accurate weighing of all the symptoms and consideration of the repeatedly described destructive processes in the thick false membrane stained by hemorrhages, the removal of these broken-down masses, and the laying bare of the mucosa,

deprived only of its epithelium, will at once make the diagnosis sure.

When actual necrosis of the tissue of the mucous membrane occurs in places under the false membranes, and we can with certainty exclude the possibility that an ulcerative process may have existed already during the earlier period of the diphtheritic affection, we shall find small or large ulcers, with sharp, reddened edges, and yellowish-gray, easily bleeding base, upon which, as upon the edges, some remnants of the earlier deposits may still be adherent. Very often cavities and depressions, scars of earlier abscesses in the tonsils, the forms of which were not previously known, are mistaken for diphtheritic ulcerations, especially where the bottom of such a depression still remains filled with a grayish-yellow exudation after the removal of all the false membranes, and even after a complete cleaning of the cavity of the mouth. But even in these, often extensive depressions, the false membranes finally come off suddenly and completely, leaving behind them a normal mucous membrane, or an old distinct cicatrix.

Secondary Paralyses.

When an attack of diphtheria has been observed, or can be proved with certainty from the anamnesis, the paralyses which gradually make their appearance after some time must be considered as additional symptoms of this process. The diagnosis is then subject to no doubt. The case is the same if the paralytic symptoms appear after external wounds, which were infected with diphtheritic matter, for the only difference here is that the primary affection has developed in another than the usual place, and the infection of the organism has taken place in another way; the ultimate general affection remains the same whether the diphtheritic contagion is received through the lymphatics of the hand and arm or through those of the organs of the throat.

Also in cases in which the anamnesis has not given a satisfactory result, a sure basis for the diagnosis can be gained in the characteristic development and order of succession of the single successive muscular paralyses. The diagnosis becomes more dif-

ficult and even impossible when this regular course is not followed, but the paralyses appear in irregular succession and especially in unilateral forms.

PROGNOSIS.

On account of the difference in the phases of development through which the diphtheritic process goes, the indications for prognosis are also different, and are preferably divided into two main groups :

(*a.*) Those which furnish a general indication of the course of the disease.

(*b.*) Those from which only a special prediction for the next stage of the disease can be made.

General Prognostic Indications.

(1.) A definite prognosis of the course and termination of a diphtheritic affection, as was indicated in the description of the development and course of this process, is in no case possible, for neither slight local lesions nor inconsiderable disturbances of the general health exclude a sudden passage into the severe forms and a fatal termination.

(2.) The prognosis of diphtheria is dependent upon time and place only when the disease spreads in greater or smaller epidemics over communities or districts, and the special cases are to be judged according to the violence of the epidemic at the time. When the diphtheria appears sporadically no difference has as yet been observed, neither in the season of the year nor in the neighborhood. (Comp. Etiol.) When the disease has been directly communicated, a prognosis can be made in the isolated cases according to the virulence and intensity of the case from which the transmission took place. The rate of mortality in the different epidemics ranges between thirty and forty per cent., and rises higher as the number of children among those attacked is greater.

(3.) The age and constitution of the patient weigh heavily in the scales of prognosis of diphtheria. With regard to the first

the prognosis is more unfavorable as the child is younger, for the spread of the disease to the larynx occurs oftenest in children, and at the same time is the most dangerous. As to constitution, when the general infection is of a high grade, and the disease lasts for a long time, the prognosis is more favorable for those who were previously healthy and strong, than for those who were badly nourished and reduced in strength, scrofulous, or weakened by other wasting diseases; but in cases in which the larynx is especially attacked, the constitution has no importance in the prognosis, but rather the age of the patient and the relative amount of endolaryngeal space are indicative.

Special Prognostic Indications.

As the different forms of development of diphtheria are distinguished from one another by the intensity of the process, so, too, do the prognoses of the individual forms vary. The prognosis is more favorable in the catarrhal than in the croupous form, and in the croupous than in the septic or gangrenous, in which it is almost invariably fatal. In the catarrhal form, which in the majority of cases ends in cure, the danger lies in its passage into the croupous form, in which, especially when it occurs in children or young persons, the spread of the fibrinous exudation upon the larynx and trachea proves fatal in the immense majority of cases, so that the average rate of recovery scarcely amounts to five or possibly ten per cent.

It must also be remembered that the prognosis is more favorable as the surface which the false membrane covers is smaller. The larger this is, the greater the danger that, on the one hand, the process may extend to the nose and the larynx, and that, on the other hand, grave septic symptoms may occur,—as almost always happens when the posterior cavities of the nose are affected.—and lead through general poisoning to death. When the septic form has developed, the prognosis is so much the more grave as the surface upon which the broken-down masses of exudation lie is more extensive, as their decomposition is more energetic, the odor from the mouth more foul, the yellowish-watery secretion from the mouth and nose more offensive and

corrosive, the involved lymphatic district larger, and the swelling of the glands and peri-glandular cellular tissue more considerable.

If the fever increases gradually during the course of such a process and assumes the adynamic type, and the temperature rises to 105° or 105.8°, complete blood-poisoning ensues, and the disease, almost without exception, ends fatally. In other cases the temperature sinks suddenly and rapidly below the normal point, the pulse becomes small and irregular, intermittent, the heart-sounds scarcely audible, the skin is covered with a clammy sweat; here, too, death is almost the invariable termination of the disease.

The prognosis in the gangrenous forms is determined entirely by those criteria which are especially indicative in gangrene.

We have finally to consider the prognosis of those cases in which wounds have been infected by the diphtheritic poison, or in which accidental wounds of the skin, intertrigo, eczema, excoriations caused by blistering, leech-bites, wounds of the trachea in tracheotomy, have been likewise diphtheritically affected by a previously existing diphtheria of the pharynx. In cases of the first kind the prognosis is always in a high degree unfavorable, and is determined by all those symptoms which are indicative for diphtheritic wounds; in those of the latter kind the prognosis of the previously existing affection of the mucous membrane is rendered more unfavorable by that of the infected wounds.

Sequelæ.

Whether secondary paralyses will develop after the termination of the disease, and what their nature will be, cannot as a rule be previously determined with certainty; but that diphtheritically infected wounds can be followed by paralysis of different groups of muscles should not be forgotten.

The more severe the affection of the mucous membrane, and the longer its duration before the fall of the false membranes, the greater is the probability that it will be followed by paralysis, the intensity and extension of which over a larger or smaller

portion of the muscular system stand, as a rule, in close relation with the severity of the primary affection.

The paralyses should be judged more favorably, as their extension is less, and as the deeper muscles of the œsophagus and larynx are less affected. The danger to the life of the patient in the latter cases lies in the disturbances produced by inanition, and also in the entrance of morsels of food into the air-passages and lungs, whereby the larger pieces may cause sudden suffocation, and the smaller ones induce pneumonia by their presence as foreign bodies. If the affection spreads gradually over the muscles of the trunk, paralysis of the muscles of respiration and of the heart is to be feared. Finally, in very severe cases certain groups of muscles may remain more or less completely paralyzed after the others have recovered their functional capacity.

Treatment.

In diphtheria we have to deal at first with an infection which is localized, and afterwards with a general disease resulting from this, out of which may ultimately be developed still a later affection of various organs. Consequently, the precise problems of treatment will be found indicated in the different phases of development of the diphtheritic process. We possess no specific remedy against the disease, but the basis of treatment will always have to be the sum-total of our acquaintance with the special pathological process, its origin, course, and retrogression, and hence the treatment will have to be divided into

I. Local;
II. General; and
III. Treatment of the Sequelæ.

Treatment of the Local Infection.

The problems to be solved in the treatment of the local infection are—

1. To treat the inflammation depending on the infection, and its immediate results.

2. To prevent septic disease and a general poisoning of the system.

In order to solve the *first problem* in a way corresponding to the knowledge and the remedies we possess, we must endeavor to confine the disease to that form in which it comes under treatment, and to prevent it from passing into a severer form; to put a stop by every possible means to the spread of the process, and to bring about a retrogression of the inflammatory process with removal of the pseudo-membranes and necrosed tissues; where the exudation has already reached the mucous membrane of the neighboring organs, the nose and the larynx, to combat the symptoms resulting from it which jeopardize life; and finally, to moderate the subjective symptoms specially related to the inflammation—viz., the pain and difficulty of swallowing.

Among the requirements comprised in the *second problem* of the local treatment must always be counted first the early and most complete removal possible from the tissues of all substances which cause the disease; secondly, the arrest or limitation, by destruction of vegetable parasites and other ferments, of the decomposition going on in the products of the disease; in the next place, the most general disinfection possible, and especially the cleansing of the mouth and throat; and finally, the prevention of any further entrance of micrococci and of the continued absorption of injurious products of decomposition from the surfaces of the diseased tissues.

How far now it is possible to fulfil these indications will be shown by a comparative examination of the circumstances connected with the retrogression of the local process, and of the remedies which promote this end.

In the management of the diphtheritic inflammation on mucous membranes we have two objects to keep prominently before us, the thorough analysis of which must prove of the utmost importance: first, the character of the inflammation itself; secondly, the signs of reaction which precede the process of repair,—the vis medicatrix naturæ. These two premises are of general significance, and will be ultimately conclusive in every therapeutic investigation.

The diphtheritic affection of the mucous membrane is dis-

tinguished as an exudative inflammation, which may increase from a simple catarrhal exudation to the pouring out of a fibrinous effusion upon the mucous membrane, or may even lead to the mortification of the tissue itself through the amount of inflammatory products and of micrococci ; at the same time the entrance of vegetable organisms into the blood and the absorption of injurious products of decomposition induce a general poisoning of the system.

Any therapeutic procedure, then, which in any way involves the danger of promoting these processes will be already barred in advance. When retrogression of the pathological process takes place, and the false membranes become detached by the unaided efforts of Nature, we find that this is invariably done through suppuration. The entrance of micrococci and the absorption of putrefying substances is prevented by a thick impermeable layer of pus-corpuscles, which at first infiltrate the superficial portions of the tissue, and ultimately pressing forth from it, form a separating stratum of pus on the surface of the mucous membrane. The process of healing, in the case of wounds which are the seat of diphtheritic infection, is accomplished in the same way, as I have repeatedly demonstrated in diphtheria of the respiratory mucous membrane ; the removal of dangerous matters is accomplished here, too, by means of suppuration.

Let us now, in view of these facts, examine the physiological operation of those means which may be employed therapeutically against the diphtheritic inflammation, and let us compare it with the results already attained by the same means used empirically.

Among antiphlogistic remedies the two principal ones are *the abstraction of blood*, and *ice*. So far as we have learned anything of the morbid process under discussion, it is clear that local blood-letting would prove of no use,—and general blood-letting is certainly not to be thought of. The inflammation of the respiratory mucous membrane caused by diphtheritic infection is not in the least altered by the application of leeches in the submaxillary region or other parts of the neck, while even a slight loss of blood will only hasten the failure of strength which is imminent without this,—not to mention the danger of

the leech-bites being converted into diphtheritic ulcers. But the application of cold, even in the form of ice, will not be capable of exercising an effect equal to the demands of the case. We must above all remember that ice is indicated in those forms of inflammation only in which, beyond a mere limitation of the inflammation, there exists the possibility that resolution may take place. Here, however, the inflammation is caused and kept up by infectious substances, by the luxuriant growth of micrococci upon which cold, as far as its employment in these places is possible, can have no destructive effect—can, in fact, scarcely check its spread. Specimens of micrococcus and bacterium termo, which, suspended in water, I exposed for twenty-four hours to a temperature of about 4° below zero, Fahr., showed themselves again capable of motion and propagation after the melting of the ice. Besides, here we have to do not with a simple inflammatory process, but with an exudative process by which thick, skin-like pseudo-membranes are thrown out upon the mucous membranes, and form the most favorable soil for the growth of micrococcus and for the processes of decomposition. It will not be possible to effect a detachment of those membranes by ever so energetic an employment of ice, and just as little can their spread thus be checked, or their histological composition altered, of which latter fact I have convinced myself by numerous microscopical investigations. Moreover, under the energetic employment of ice the fibrinous secretion keeps constantly going on, while a purulent infiltration of the membranes can only occur sparingly or not at all; hence the formation of a purulent layer of demarcation and the spontaneous detachment which results from it become almost impossible. The result, then, attained empirically with this remedy quite agrees with our investigations. It is impossible to use ice continuously for a considerable time, and even the moderate use of it will generally have to be discontinued after three or four days. The only thing that can occasionally be accomplished by ice is, in certain cases, to diminish the pain (seldom permanently) in the inflamed parts; but the painfulness of diphtheria is exceedingly slight in comparison with an ordinary phlegmonous angina, and stands in no sort of relation to the real severity of the disease; so this sub-

jective alleviation, which can, for that matter, be attained by other remedies, must not be considered as sufficient to decide the choice of this as a therapeutic procedure.

Two modes of treatment must next be considered. The first consists in the effort to remove the seeds of the infectious material from the mucous membranes, by mechanical detachment of the pseudo-membranes, or by destroying them with caustics or chemical solutions; the second aims to effect, by astringents mainly, a contraction of the inflamed mucous membrane, and a limitation of the exudation.

Now, as far as concerns the *mechanical* detachment of the pseudo-membranes, as being sources of inflammation, it certainly requires only a brief reference to the pathology of the process to make evident the uselessness and danger of such an interference. It cannot be enough insisted on that in diphtheria of the mouth and throat the contagious material is not confined to the false membranes, but is present throughout all the mucous membranes involved, as well as noticeably in the fluids of the mouth, in greater or less quantity. If now we attempt the mechanical detachment of the deposit, which in the beginning of the process is still quite firmly adherent, it always results in the production of small wounds of the surface of the mucous membrane, as shown by bleeding points where the individual capillaries have been torn. The possibility of an easier and considerable entrance of vegetable parasites and products of decomposition into the tissues is thus readily afforded, and, as proved experimentally, the life of the patient is put in far greater danger. The immediate result of such mechanical violence is, as a rule, the rapid reproduction of the pseudo-membranes, and at the same time they spread over a greater extent, owing to the increase of local inflammation and fibrinous exudation. But the final results, where such a procedure has been resorted to, are extraordinarily bad; the vast majority of patients, and, where the diseased process is intense, the whole of them, succumb to the infection of the general system.

In the attempt to combat the local process by *cauterization*, we meet with a state of things similar to what occurs when a simple mechanical detachment of the pseudo-membranes is

attempted. This procedure was one of the earliest employed against diphtheria, and since it agreed very closely with the theoretical views held on the subject, it was soon very widely adopted. Not only is it impossible completely to annihilate the diphtheritic contagious material, even by repeated cauterization, when it has once become diffused throughout the whole buccal cavity,—though every patch be never so carefully destroyed,—but it is also impossible to combat the local disease by attempts to convert the specific inflammation into a simple one by these cauterizations. The immediate result of even the most prudent cauterization is always a certain degree of mechanical violence to the inflamed mucous membrane, and the more circumspectly we endeavor to destroy all the grayish-white deposits, the more is the subepithelial tissue of the mucous membrane laid bare, the resulting slough failing to afford thorough protection in the way of a covering. In the cavity of the mouth, and in the mucus and saliva it contains, growths of micrococcus, as products of decomposition, are present in sufficient quantity to easily find their way into the lacerated parts of the mucous membrane, even though these be scarcely as large as a pin's head, or only discernible with the microscope; and besides, the increased inflammation caused by the mechanical and chemical irritation furnishes a much more favorable soil.[1] I was enabled to observe these facts and prove them experimentally as long ago as 1864 and 1865. There can be no doubt, then, that the unfavorable results which have been attained on all sides by cauterizations, more or less energetically practised, must put a stop to this procedure, even if in its stead we should be obliged to resort to the opposite, the purely expectant and symptomatic treatment.

But even the attempt to dissolve the pseudo-membranes chemically will prove practically valuable only so far as it can widen the space encroached upon by the membranes. But the danger of suffocation is scarcely to be feared when the throat alone is affected, however thick the membranous deposits may be, but only when the larynx and trachea are involved at the same time, and when, owing to the encroachment of the mem-

[1] Compare Aertzl. Intell.-Bl. 2868. No. 31.

branes, it becomes of vital consequence to remove them. With regard to the affection of the mucous membrane itself, as well in the case of the mouth and throat as in that of the other air-passages, the solution of the false membranes by chemical means cannot, as I have shown, have the least influence so long as the inflammation itself is not subdued; after dissolving the pseudo-membranes a new fibrinous exudation takes place, a second one forms, and even sometimes a third, without the treatment having gained any advance upon the disease. It is a necessary condition for improvement that after the removal of the false membranes the exudation also should cease, and a corresponding reaction, with energetic production of pus and new formation of cells, should take place upon the mucous membrane, which has been deprived of its epithelium, and perhaps, too, of the uppermost of its layers of connective tissue. The danger, too, of a general systemic infection is just as little diminished by the chemical detachment of the pseudo-membranes as by the mechanical, and besides in the former case the possibility of the introduction of masses of micrococcus and of decomposing substances into the mucous membrane, already laid bare and deprived of its epithelium, is greatly increased; the vegetable parasites and products of decomposition present in the mouth and pharynx are just as little destroyed by the chemical agents used for dissolving the membranes as by the caustics, which were formerly employed locally, When, therefore, it is not a question of treating a mechanical closure of the air-passages, or of averting the danger of threatening suffocation, we have no reason for using this procedure.

Lastly, it was quite early thought possible to obtain by *astringents*, especially in the form of gargles, "an increase of the organic cohesion of the mucosa," and thereby to antagonize the threatened loosening and dissolving of the tissue. Without considering the theoretical notion lying at the foundation of this treatment, no diminution of the exudation on the inflamed mucous membranes could be obtained by ever so energetic an employment of these means; but, on the contrary, through the irritation caused by these articles an increase of the inflammation would be occasioned and kept up. Just the same conditions obtain here as in exudative inflammations in other mucous

membranes; if an energetic treatment with astringents is employed in the acute stage, we have as a result an increase of the diseased process. But even supposing it possible to obtain a diminution of the fibrinous exudation by such means, still nothing would be gained in this way towards the cure of the processes of inflammation and decomposition in the mucous membranes. Neither does it effect the detachment of the pseudo-membranes and destruction of the masses of micrococcus, since these, unless nature interposes a boundary by the formation of pus, may continue to grow unmolested within the tissues; nor is a stop thereby put to the decomposition of pathological products, and the possible formation of injurious substances in the mouth and throat. Finally, as concerns the statistics of the empirical results, they do not testify in favor of the curative action of these remedies, since the astringents have proved themselves completely useless in every important case; and in the great number of cases which run an easy course, and are confined to a local manifestation, the favorable results are capable of an entirely different explanation.

In contrast to these various methods of limiting the further progress of diphtheria by antiphlogistic, caustic, astringent, and similar means—the intent of which is to combat the inflammatory reaction of the mucous membrane caused by the fungi—is the effort which has been made to excite energetically a rapid and abundant production of pus. I endeavored to solve this problem by the employment of moist warmth, in the form of hot vapor, by means of which a temperature of from 113° to 122° Fahr. was kept up for a considerable time in the mouth of the patient, and I could at once determine the appearances of reaction due to the attempt, viz., an abundant suppuration, causing demarcation.

The first appearances which are observed as a result of the operation of hot vapor are always constant, and distinctly noticeable as early as at the end of from twelve to eighteen hours, during which the inhalation has been practised hourly or half-hourly for a quarter of an hour at a time; but these effects will be developed more slowly, if a considerable fibrinous exudation, with partial decomposition of the pseudo-membranes,

has already taken place, and the capacity for reaction of the tissues is almost extinguished; or they will not be induced at all where the process has already run into septicæmia. The margins of the diphtheritic deposits, which generally pass imperceptibly into the surrounding tissues, become more sharply defined and contrast strikingly with the intensely reddened mucous membrane. The membranes therefore at the first glance seem enlarged. In some places, too, it will appear as if new membranes had formed, where before there had been none; this is due to the fact that they had previously escaped notice from their small size and from the presence of mucus, which concealed their outlines. Thus it will appear as if the disease had increased in intensity. The operation of the hot vapor, however, has been to induce a considerable excretion of pus-corpuscles, and these have infiltrated the epithelium, or its delicate network, which was already infected and grown full of micrococci. Under longer continued operation of the hot steam, soon no further enlargement of the patches will be noticed. The pseudo-membranes become gradually thicker, are raised up from the mucous membrane; their whitish-gray color becomes more yellowish or of a dirty gray, and their surfaces wrinkled and uneven, while the redness of the adjacent mucous membrane also fades and the swelling disappears. After some days we obtain with the necessary amount of suppuration a complete detachment of the pseudo-membranes, and they are expectorated by the patient, either whole or in single, scarcely noticeable fragments, or are possibly in part swallowed. The thickness of such membranes as a rule never amounts to less than two mm.

If we examine the structure of these membranes on vertical section, we find that their upper layer, for perhaps a third of their thickness, consists of broken-down epithelium, flakes of fibrine and of fibrinous twigs and branches, crowded closely together, forming great open spaces and alveoli with a stellate arrangement, in which considerable colonies of micrococci have been deposited in balls and spherical masses. Also between the single branches and twigs micrococci are still discernible, scattered in nests and strips. Towards the second third of the membrane, the single branches and twigs of the fibrinous network are

gradually lost, numerous pus-corpuscles infiltrate their single meshes, and are constantly crowding up; the fungus growths, too, keep diminishing, so that ultimately the under half of the membrane consists merely of pus-corpuscles, thickly crowded together, and scanty coagula, the whole forming a thick wall of separation between the primary pathological products and the mucous membrane itself. Where numerous capillary hemorrhages have already occurred, with extensive fibrinous exudation, and the thick, brawn-like deposits have acquired a brownish or blackish appearance, the first signs of purulent infiltration are less distinctly noticed. The fibrinous exudation gradually ceases, and after a few days the membranes are cast off in large, connected pieces, this result being due to the process of suppuration, which separates and detaches the twigs of fibrine from the tissues. The masses of mucus, too, which have collected under the membranes, may possibly contribute to their detachment. For a short time some pus still continues to be secreted on those parts of the mucous membrane which have become free, but it disappears with the rapid development of the young epithelium.

In the application of the hot vapor an ordinary broad pot, with boiling water or infusion of mallows, can be used, from which the vapor as it forms is conducted through a suitable funnel, as hot and abundant as possible, into the mouth of the patient; or, if we prefer it, we may use an apparatus which is expressly made for such purposes. This apparatus, which I have used for several years, wonderfully facilitates the employment of hot vapor, especially with children; the wide conducting-tube is simply placed in front of the open mouth, or is allowed to be taken into the mouth itself, and a uniform development and introduction of the hot vapor is thus secured. With this apparatus we can at the same time accomplish a thorough cleansing of the cavity of the mouth and throat from mucus and the fluids of the mouth, by employing a fluid which dissolves the mucus, but which at the same time acts indifferently on the organism. Such a fluid, steadily flowing over the mucous membrane, washes away masses of mucus, remnants of food, and other products of decomposition. We can also use suitable weak

solutions of chloride of sodium, or chlorate of potash or other alkalies, only we must avoid strong disinfecting substances, such as carbolic acid or permanganate of potash, because, after long-continued inhalation, more or less of these substances is always carried into the bronchi and may produce symptoms of irritation.

Solutions of common salt, or chlorate of potash, if this latter be preferred, of the strength of from ten to fifteen grains to the ounce, produce no injurious effect upon the organism, that is, they act perfectly indifferently when so used; and a long series of forced experiments, such as are not usually carried out in practice, never resulted in an affection of the bronchi or of the lungs. How long these operations should last, and how often they should be repeated, must be determined by the degree of the affection, and it should not be forgotten that the shorter we make the sittings, and the longer the intervals, so much the more slow and uncertain do we find the reaction, while the disease thereby gains in intensity and extent. If, therefore, we aim at producing a rapid and free suppuration, the inhalations must be practised as often and as long as possible, in quarter-hour sittings every half hour, and on the first and second day three, or at the utmost four hours of sleep must suffice for the patient, while nourishment must be supplied in small portions in the intervals between the separate sittings. Later on, when the pseudo-membranes have been partially cast off, as well as in certain lighter cases, hourly sittings of about a quarter of an hour's duration suffice, and a longer time—six or eight hours—can be allowed for the night's rest of the patient. Even when a complete separation of the membranes has taken place, so long as a secretion of pus is still perceived at the diseased places on the surface of the mucous membrane, occasional inhalations should still be practised every two or three hours, and these are also finally to be suspended after the cleansing of the mouth and throat is complete. By employing the atomizing apparatus a cleansing of the mouth and throat can also be combined with the inhalations; if a simpler mechanism is employed, these cavities will have to be kept clear of the accumulated masses by industrious washing and syringing. Disinfection and destruction of the micrococcus growths, of the products of infection and decom-

position, will not of course be attained thereby. The effort to fulfil these indications belongs to the second problem of the treatment of the local infection.

2. Prevention of septic disease and general systemic poisoning.

We possess no method of completely disinfecting the diseased organs.

It follows from our investigations into the treatment of the local inflammation, that it is impossible to annihilate the diphtheritic contagious material completely by mechanical removal of the deposits from the mouth and throat, or by destruction of them with caustics. Another way in which the objections inherent in these methods may be overcome is one which has long been a favorite in therapeutics, viz., to destroy, by industrious gargling and rinsing of the diseased cavities, the septic ferments and the substances which have entered upon decomposition and are acting as poisons. A glance at the history of diphtheria and its treatment shows that attempts of this kind have at no time been wanting. The most usual remedies for counteracting, as far as may be, the fungous growths and the progressive decomposition, and for limiting their entrance into the tissues and their absorption, are pre-eminently spirits of wine and diluted chlorine water, in the proportion of one to three; in the next place, solutions of carbolic acid or permanganate of potash, one or two grains to the ounce; besides these medicaments, solutions of hypochlorite of soda, forty grains to the ounce, and of hyposulphite of soda, twenty-two grains to the ounce, and the crude flowers of sulphur, are also esteemed for the same object.

It is possible to employ anti-fermentative and disinfecting means only within very narrow limits, without, at the same time, irritating and wounding the tissues; while the resistance which the micrococci and decomposed substances offer to physical and chemical agents is exceedingly great, so that in determining their relations many a therapeutic illusion is suddenly dispelled. The vitality of vegetable organisms is best recognized at any time by the energy of their spontaneous movements, and their increase at the same time under circumstances which would be thought sufficiently unfavorable to destroy them altogether. The question of movements may be determined at once by microscopic investigation; that relating to their capacity for reproduction I have sought to prove by mixing Pasteur's artificial fluid with the (supposed) disinfected preparation, according to Cohn's plan,

and keeping it under observation with the necessary precautions. Diphtheritic microcoeci which were exposed to the influence of a cold of from 14° to 5° Fahr., while suspended in freshly distilled water, again showed lively independent motion[1] immediately after the thawing of the frozen preparation, and a drop of this added to sixteen minims of Pasteur's fluid had, on the second or third day, already filled it with innumerable masses of these vegetable organisms. I obtained a similar result if I diluted two drops of the same fluid containing microcoeci with thirty-two minims of distilled water and allowed a strong boiling heat to act upon it for a quarter of an hour. By this experiment was shown indisputably the impossibility of destroying the vitality of vegetable organisms in the mouth and throat by the employment of cold in any form whatever, such as ice-compresses, ice-pills, or gargling with ice-water, and of thus limiting the advancing decomposition, and that it will be just as impossible by means of heat alone to destroy these germs, and thereby effect a cure of the diphtheritic process.

These bodies act in the following way when exposed to the operation of chemical substances in appropriate solutions: a drop of fluid containing microcoeci, obtained by repeated washing of diphtheritic membranes, is added, with the necessary precautions, to twelve drops of the medicament we are investigating, and then examined after from twenty-four to forty-eight hours. In solutions of the sulphate of quinine, from half a grain to two and a half to the ounce, after twenty-four to forty-eight hours, the bacteria not only retained their mobility completely, but had increased in numbers extraordinarily, and indeed to such an extent that after forty-eight hours a fine pulverulent deposit had formed at the bottom of the test-tube, and the fluid became slightly turbid on shaking. Solutions of chlorate of potash, ten grains to the ounce, gave similar results, and also solutions of alum, twenty grains to the ounce, which substances have met with special favor in diphtheria, the former almost as a specific agent against it, while ten to twenty grain solutions of corrosive sublimate, or of the sulphates of iron or copper, Lugol's solution, alcohol diluted with equal parts of water, and from 0.2 to 0.4 per cent. of prussic acid[2] markedly reduced the mobility of the vegetable organisms, and showed that only a slight increase in their number had taken place. Chloroform- and ether-water, as well as crude and washed flowers of sulphur,[3] if added to a fluid containing micrococci, as I have already stated elsewhere, develop only slight anti-fermentative and disinfecting properties, quite insufficient for therapeutic purposes. The most

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[1] If a drop of alcohol is added to the microscopic preparation, the mobility of the bacteria ceases at once, and the defunct cells lie completely motionless in the fluid, or simply drift to and fro with the currents that may be formed in it, without that lively, rotating, circular movement which is peculiar to such organisms.

[2] Equivalent to the U. S. dilute acid in from ten to twenty parts of water.

[3] I have already shown in another place the completely delusive operation of sulphur in diphtheria, by experimental investigations, as well as convinced myself of its useless ness by numerous carefully conducted trials on the patient. Journ. für Kinderkrankh. (Jahrb. v. Pr. Hauner pr., 1868.) Vol. LIV., p. 18, 1870.

favorable results were obtained from freshly prepared chlorine-water, fifteen to thirty parts to one hundred of distilled water, from a solution of carbolic acid, two and a half to five grains to the ounce, from oil of thyme, one per cent. dissolved in equal parts of spirits of wine and water, and from a solution of permanganate of potash, one and a half to two and a half grains to the ounce, by means of which latter, and more especially by means of alcohol of 96° (Trall), the vitality of the vegetable organisms and their multiplication were completely done away with. A full account of the experiments themselves, which were frequently repeated, would lead us too far at the present time, and the results will be sufficient to give a general survey of the possible efficacy of the various chemical agents.

I have not yet finished the whole series of experiments on animals, viz., inoculations of muscular tissue with diphtheritic membranes kept for a quarter to half an hour in similar solutions, yet I can already adduce the results of the operation of chlorate of potash, of permanganate of potash, and of spirits of wine as corresponding with the above experiments.

The most suitable remedies, then, to meet the indication of opposing septic infection and general poisoning of the system successfully, are, on the basis of experimental investigation, alcohol, freshly prepared and properly diluted chlorine-water (containing fifteen to thirty per cent. of chlorine water), solutions of permanganate of potash, one and a half to two and a half grains to the ounce, and of carbolic acid, two and a half grains to the ounce, or where this cannot be borne, a like solution of oil of thyme in equal parts of spirits of wine and water. Since these substances, on account of their concentration, are not suited for inhalations, in which a certain portion is always liable to reach the lungs and occasion symptoms of irritation, they will most judiciously be used as gargles. With these the patient has to rinse his mouth once or twice at least every hour, or where this is not easily possible, as in the case of small children, we must seek to cleanse the mouth and throat by the use of the syringe.

But rational and promising as this antiseptic and disinfecting method appears, still we must never lose sight of two points, *viz.*, that by these means *no limits* are set to *the inflammation* and *exudation* on the mucous membranes : on the contrary, possibly even an increase of these may be induced ; then, in the second place, that owing to the fact that these *fluids only occasionally bathe the mouth and throat, a complete destruction* of the

masses of micrococcus *cannot be effected*, for they grow not only in the thick, brawn-like deposits, but they may have already gained entrance into the tissues of the mucous membrane and into the serous canaliculi and lymphatic vessels. We cannot. then, procure a complete destruction of these parasites by any one of the gargles which have hitherto been available, unless we are willing at the same time to cauterize destructively both the healthy and diseased mucous membrane, with all the results already detailed.

Empirical knowledge, gained by practice in the treatment of diphtheria with antiseptic gargles for years past, quite agrees with these results, and the various specific remedies of this kind have in no way stood the test of experience.

There is a possibility that the organism may limit and even prevent septic disease and a general infection, through the *capacity for reaction which belongs to the affected tissues.* This is also the way in which Nature herself effects a cure. I have repeatedly called attention to these facts, which I have observed during several years past, and Prof. Eberth, in Zürich, has expressed a similar opinion in regard to the healing of diphtheritic wounds.

In the case of the mucous membrane deprived of its epithelium and covered with fungous growths and inflammatory exudation, if a due reaction sets in and the cell-formation is active, as in a diphtheritic wound, the micrococci are washed away with the pus ; or in case a thick layer of fungus has already been formed, this will be removed by a suppurative process of demarcation. Inversely, in case of slight reaction of the tissue, with rapid increase of the parasites, the suppuration which ultimately sets in will no longer suffice to check the further advance of the fungi and septic materials, that is, to prevent the local and general infection. Finally, certain individual differences in the capacity of reaction of the tissues are also severally liable to favor or retard these processes, and this very difference, to which we would call special attention, must also take a part in those cases in which the fungus cannot be regarded as the only cause of suppuration.

To set up a rapid and abundant suppuration will then form

one of the first indications of our present task, and with this we should always combine the use of antiseptic gargles to secure the utmost possible cleansing and disinfection of the cavities involved. By the energetic use of hot vapor this demand will be met agreeably to nature, at the same time that the separation of the pseudo-membranes is hastened by it; the micrococci are partly taken up by the rapidly forming pus-corpuscles and partly washed away by them, and an impermeable layer is opposed to the septic masses, until finally the false membranous layer becomes completely detached from the rapidly regenerating tissue of the mucous membrane. According to the individual peculiarity in capacity of reaction will this separation occur more or less rapidly; and it will depend upon the height the disease has already reached whether the septic affection and general poisoning can be prevented, and how far this can be done.

The mode in which the hot vapor is to be employed to meet this indication will be the same as that which was found suitable in combating the local inflammation; the number and duration of the separate inhalations will be arranged in accordance with the intensity and extent of the local process, since the elimination of the fungi and septic materials follows at once upon the casting off of the membranes. The longer the disease has already lasted, the greater the extent of the exudation and the more rapid its decomposition, so much the more energetically must the use of the vapor be pushed, the highest possible temperature being used, and the quarter-hour sittings following each other at intervals of half an hour; at the same time the mouth and throat must be carefully gargled or syringed out *every hour* with diluted alcohol or solutions of carbolic acid and permanganate of potash, two and a half grains to the ounce.

Now, although the principles of the local treatment of diphtheria, as determined by pathological and physiological considerations, also generally serve as our guide in the affections of adjacent organs, still certain modifications must enter into this treatment if the diphtheritic process has occasioned a pseudo-membranous exudation on the mucous membrane of the nasal cavity, the larynx, the trachea, and the bronchi.

(a.) Affection of the Nasal Cavity.

Whether the nasal cavity became affected primarily, or whether the disease spread to it from a neighboring locality, the danger in both cases lies in the general poisoning and septicæmia which follow most rapidly when the abundant exudation-products collect in the niches and sinuosities of the nasal cavity, from which it is very difficult to remove them. Under the influence of micrococci and of the air, these rapidly putrefy, and may determine the formation of excoriating discharges and poisonous substances.

The *first indication* will therefore require us to *keep these cavities most carefully clean*, and to prevent in every possible way the decomposition which is likely to take place in them. We should therefore institute syringings with disinfecting fluids, such as the above-mentioned solutions of permanganate of potash, of carbolic acid, etc., repeated every hour or two, and with the greatest attention. In doing this we must avoid any wounding or unnecessary irritation of the mucous membrane, already highly swollen and very vulnerable, so as not to lay open any more ready means of entrance for the micrococci. For the more thorough rinsing and washing out of mucus, excoriating fluids and shreds of exudation, repeated syringings with lukewarm chamomile tea answer a good purpose. They may be practised first through the nostrils, and then, by means of a suitably curved syringe introduced behind the soft palate, we may thoroughly bathe all the cartilages and passages of the nose. According to the age of the patient, we can also, by the aid of Weber's nasal douche, completely flood the fossæ, and, instead of simple syringings with weak infusions of chamomile tea, we may allow weak solutions of common salt to flow through the nose for some minutes. Should an abundant formation of pseudo-membranes have led to a complete stoppage of the nasal passages, and thereby produced an accumulation and damming up of the products of decomposition and eroding fluids, the removal of these plugs must at once become a matter of prime necessity in treatment. To accomplish this, a chemical solution of the membranes, by injections of suitable fluids (to the more thorough examination

of which we shall come immediately), is to be preferred to the simple mechanical removal of them, which can never be effected without wounding some part of the mucous membrane. One per cent. solutions of lactic or acetic acid, or a five-grain solution of carbonate of potash, or preferably lime-water, will answer best for this purpose. By repeated syringings into the closed nostril, the obstructing plugs of fibrine are gradually loosened, and a passage made for the discharge of the secretions and putrefying matters. Of course it will be a matter of the greatest importance in the subsequent local treatment to remove and disinfect these masses. As regards the employment of hot vapor, we are generally obliged, owing to the narrowness of the passages, not only in children but also in adults, or on account of various malformations and curvatures of the septum, abnormal development of the anterior parts of the inferior and middle cartilages, etc., to renounce its use altogether in these parts.

(b.) Affection of the Larynx and Trachea.

The local treatment of the affection of the larynx and trachea is distinguished from that which is indicated in the affection of other organs in this, that the age of the patient and certain considerations of size afford two different indications, of which one belongs to diphtheritic affections in general, while the other at once becomes of itself an indication of vital importance in the treatment.

If the *larynx* is affected *in adults*, there will only in rare cases be a constriction of the glottis from the rapid extension of the fibrinous exudation; still less does the diseased process, if continued into the trachea, produce a narrowing of it; while the air-passages always afford space enough for respiration, and the treatment will therefore mainly agree in all essential points with the principles described for the local treatment. Only the inhalation of the stronger solutions of antiseptic substances, as made use of in gargles and in syringing the nose, is here contraindicated, for fear of their exciting inflammation of the smaller bronchi and of the lungs; and, since weaker solutions do not answer the requirements, other fluids must be employed for

inhalations, such, for example, as cleanse the air-passages of mucus and shreds of exudation, and such as gradually dissolve the fibrinous deposits. When in the course of the disease, in spite of the relatively great space, symptoms of suffocation show themselves owing to the abundant exudation and the infiltration of the mucous membrane, the same vital indication will be presented as determines the treatment at the outset in young persons.

Laryngeal diphtheria in *young persons* and in the majority of women will at once, with the earliest appearance of the affection, furnish urgent requirements, viz., first, the restriction of the exudative process; secondly, the removal of the rapidly increasing obstruction in the glottis.

As already explained, we are not in a position to meet the first requirement. We know of no remedy or procedure whereby we can cut short the excretion of fibrine upon the surface of the mucous membrane when it has once begun, and thus prevent the further increase in thickness of the fibrinous deposits. Even the favorable reaction and natural healing of the tissues under the influence of the hot vapor is, properly speaking, only a changing of the exudation from a fibrinous to a suppurative one, and the detachment of the membranes thus obtained will in the first place occasion an increase in their thickness from the energetic production of pus. We have never been able, by the use of caustics and astringents, to limit the exudative process on the mucous membrane of the throat, where, too, it is most easily accessible to local treatment; on the other hand, we have often promoted the exudation in a notable degree by our therapeutic interference. While it is very unfortunate not to be able in some way to meet an urgent indication, in the presence of a diseased process so dangerous to life, it is in the highest degree important that we should clearly understand the state of the case, so as not, by well-meant interference, such as cauterization of the larynx with nitrate of silver, etc., to induce artificially an increase of the rapidly developing exudation, and thus to do the patient a yet greater injury.

The second requirement, which is to be regarded as strictly a vital indication, demands *unconditionally the removal of the*

mass which is constricting the glottis, to save the patient from the immediate or unavoidable danger of suffocation. The choice of the means is greater, owing to the urgency of the situation, so that modes of interference which in other places would have to be shunned, here appear to be indicated, and the bare possibility of a favorable turn is to be weighed against the otherwise absolutely fatal result.

The removal of the pseudo-membranes from the larynx and trachea, and the avoidance of the danger of suffocation due to them, may be effected:

1. Mechanically, either by the administration of emetics so as to effect the detachment and expectoration of the membranes by the effort of vomiting; or by passing suitable instruments into the interior of the larynx, so as to withdraw the membranes by artificially separating them.

2. Chemically, by the inhalation of medicated fluids capable of dissolving the fibrinous coagula which lie upon the mucous membranes; or, finally,

3. By tracheotomy, through the establishment of a fistula below the constricted organ, and the removal of whatever membranes may be filling up the trachea below.

With regard to the first, the employment of emetics, tartarized antimony and sulphate of copper in particular have been been adopted in practice to fulfil the present indications, and ipecacuanha is added to them, being administered in combination with tartarized antimony when it is desired to prolong the nauseating effect, as well as to produce vomiting. For a more complete account of their effects, which differ to a certain degree among themselves, for their differential indications, and for other practical information, in order to avoid repetition I will venture to refer the reader to the chapter on croup.

The mechanical removal of the membranes appears not to be indicated in the treatment of diphtheria of the throat, but finds its justification in the affection of the larynx, in the possibility of avoiding an otherwise certain death from suffocation by extracting the exudation which constricts the glottis. I have so far had the opportunity of observing a favorable result from this proceeding in three out of eight cases, viz., in three children of five

six, and eleven years; while with the other patients, in whom this treatment was likewise employed, death was occasioned by repeated and rapidly following fibrinous effusions. In carrying out this procedure I made my way into the interior of the larynx, when possible under the guidance of the laryngoscope, with a blunt camel's-hair pencil attached to a handle suitably curved, and sought to detach the pseudo-membranes from the mucous membrane by rapid rotatory movements. The child gags a little, and the membrane now either remains on the instrument and is brought out with it, or is immediately after rejected by the child by the aid of its short coughs and chokings. The precise time for this operation, as shown by the vital indication, seems to be the moment when the patient threatens to sink from suffocation; and the favorable conditions for undertaking it are found at the time when purulent infiltration of the membranes has already occurred and their rapid increase in thickness is due less to the secretion of fibrine than to an active production of pus. For this reason it will be proper to undertake the operation only at the latest possible moment, and only when indicated by immediate danger to life; when the secretion of fibrine is in full activity, a point of time which unfortunately we cannot positively determine, the removal of one membrane will only result in the immediate formation of a new one.

With regard to the second, the inhalation of atomized medicated fluids, it has become possible in the treatment of fibrinous exudations in the larynx to employ remedies which are capable of chemically dissolving these coagula. In practice this idea was at once seized upon with great eagerness, and remedies so employed were brought into use in great variety, alike acids and alkalies. Now by themselves all these chemical agents, if inhaled even in the greatest possible amount, will in the most favorable cases only render fluid and capable of expectoration a thinner or thicker layer of the pseudo-membranes, according to their power of dissolving, but will not have the least influence on the course of the diseased process and on the active exudation. The same thing will happen here as in the mechanical detachment of the membranes, and, as I have repeatedly had the opportunity of observing, the most complete solution of the first membrane

does not prevent the possible formation of a second or third, nor avert death from suffocation. Only where an energetic production of pus is already attained by the reaction of the tissue, can an otherwise inevitably fatal result be avoided by the liquefaction of the fibrinous coagula and their expectoration. The fibrinous coagula in the larynx and trachea dissolve in various degrees in organic acids—lactic, formic, acetic, succinic acid, etc.; and in alkalies—caustic potash, carbonate of potash, acetate of potash, carbonate of lithia, lime-water, etc.; and the experiments which I have repeatedly performed with these substances, both on freshly removed diphtheritic membranes and on croupous membranes artificially produced in rabbits by the instillation of ammonia into the trachea, gave corresponding results.

Organic Acids.—A small fragment taken from a pseudo-membrane perhaps a sixteenth of an inch thick, and weighing about three grains, when soaked for five minutes in half an ounce of a five to ten per cent. solution of lactic acid, became transparent, and, after five to ten minutes more, separate flakes began to detach themselves; after about fifteen to twenty minutes the membrane was changed in part into a flaky mass. Solutions of a like percentage of formic and succinic acids showed the same behavior, while a corresponding solution of acetic acid retained the pieces of membrane for a longer time swollen and transparent before separate flakes began to be detached from them. In a solution of butyric acid of like strength, the pieces after half an hour appeared swollen, partly transparent, and gelatinous on the surface, but they always retained their compact structure. A solution of oxalic acid altered the membranes only a little; on the other hand, tannic acid hardened them into a whitish, compact mass, which was gluey and brittle, and could be cut by the knife like hardened pieces of tissue.

Alkalies.—In similar alkaline fluids, pieces of membrane of about the same size were altered in the following way: In a twenty and forty grain solution of caustic potash the pieces were little altered after from five to ten minutes; the edges of the sections became somewhat translucent, and only at the end of from fifteen to twenty minutes had the upper layer softened to a viscid consistency and separate parts become detached, while fre-

quently the middle portions still remained tough. Twenty grain solutions of carbonate and acetate of potash acted in the same way; after fifteen minutes began a breaking down of the masses which had softened to a viscid state, and after about an hour and a half they were almost completely dissolved. Ten-grain solutions of carbonate of lithia and carbonic-acid water in most cases altered the surface of the membranes to a viscid consistency in some ten minutes; after the action had continued for from thirty to forty-five minutes longer, the rather more resistant portions of membranes were still found undissolved. Officinal lime-water in the first ten minutes showed about the same effect as the alkaline fluids mentioned above; but after the lapse of not more than fifteen or twenty minutes, particles of greater or less size gradually separated from the membranes; and after from thirty to forty-five minutes they were completely broken down, and with a slight agitation of the test-tube dissolved into a turbid, flocculent fluid. A bromide of potassium solution of bromine, as stated by Schütz, after three-quarters of an hour's operation, and even longer, showed no special capacity of dissolving the membranes; they were somewhat swollen, it is true, but the pieces had completely retained their tough consistency.

It is of course understood that in such investigations the structure of a membrane and the thickness of its fibrinous layers will be of influence, and a thick membrane composed of a substantial framework will act differently from one formed of a delicate network and of fine meshes of fibrine, or one infiltrated with pus. In the above investigations I always selected the toughest and most solid membranes.

In half an ounce of a five to ten per cent. solution of lactic acid, a piece of pseudo-membrane weighing three grains swelled up in fifteen or twenty minutes into a loose, flaky mass, which could easily be divided, and, therefore, was also capable of being expectorated by the patient. In lime-water a membrane of the same size, in a like period of time, was altered in a similar way, and, after from thirty to forty minutes, was completely dissolved. But in this experiment it is taken for granted that the lime-water acts in the same way when inhaled as when contained in a test-tube, and that its lime is not converted, as may

be assumed with certainty of its operation in the air-passages, into carbonate of lime by the air which passes over it and which contains carbonic acid (compare also Senator). In its power of solution the carbonate of lime must certainly stand next to lime-water, and moreover we need not fear a conversion of one into the other, or a change in its chemical action.

Apart from the power of solution possessed by the fluid inhaled, its therapeutic effect will be further dependent on the quantity of it actually drawn into the larynx and trachea; one-fifth per cent. of lactic acid, a twenty-grain solution of carbonate of lime, and also lime-water, will therefore need to be inhaled for a quarter of an hour at a time, at least every half hour, and in urgent cases at intervals of ten or fifteen minutes, if a liquefaction of the membrane is to be attained. In case of insufficient, superficial inspiration, of far-advanced illness, and commencing failure of strength, the atomized medicines will never enter in sufficient quantity to effect a satisfactory chemical solution of the obstructing masses of fibrine. But finally it should not be forgotten in this procedure that a complete solution and expectoration of the fibrinous coagulum may result from the action of the fluid inhaled, and yet the child die from suffocation, as when after one membrane is dissolved a new one is formed by the continued excretion of fibrine, and the rapid development of collapse renders any further treatment impossible. I have myself twice had occasion to observe this sad event.

With regard to the third step of the treatment, we may, as a last attempt to rescue the patient from death by suffocation, resort to the establishment of *a tracheal fistula*. It is clear that the prognosis of this operation will be so much the more unfavorable, because of the extraordinary danger to which wounds are in themselves liable from the possibility of their being secondarily affected, and this danger is particularly great in this locality, where a mucous membrane has to be cut through, which is already the seat of diphtheritic disease, or else is in close proximity to the portion which is diseased, so that the process may attack the incised wounds the very next hour. The results attained by the practice of this operation only too surely confirm the very great danger inferred *à priori*. According to the notes

of Prof. von Nussbaum, which he has most kindly communicated to me in this matter, of twelve undoubtedly diphtheritic children, whose ages varied between three and four, and on whom he had performed tracheotomy, all died; and only two older ones, whose ages were twelve and fourteen, survived, but in them the whole course of the disease had shown itself much more favorable. If, now, figures are to be found in literature which furnish much more favorable statistics of tracheotomy in diphtheria, these data cannot be considered as trustworthy so long as the boundaries between croup and diphtheria are not precisely defined; in the cases referred to above the diagnosis of diphtheria was established beyond a doubt. It is very evident that the issue of such an operation should be wholly different if the case is one of a simple exudative process in the respiratory mucous membrane following a local inflammation of high degree, and not one in which the local trouble is the primary localization of a general infectious disease.

The establishment of a tracheal fistula will only be indicated when the local affection preponderates, when the general symptoms are put more in the background, and sudden suffocation forces us to rapid treatment. Tracheotomy is always to be attempted as the last resource when we can convince ourselves by examination with the mirror that the rapidly developing stricture of the glottis is occasioned less by fibrinous deposits than by a high degree of infiltration of the submucous tissue, œdema of the mucous membrane, and the limited outward movement of the vocal cords resulting from it. Under these circumstances the accumulation of a tough, viscid, suppurative, or partly plastic secretion may suddenly close the glottis, or continuous spasms threaten death by suffocation.

Finally, the glands of the neck and their surroundings, which are the seat of inflammatory irritation, are also the object of local treatment.

In almost all cases moist, warm compresses about the neck, to be renewed two or three times a day, will sufficiently quiet the irritation; or where these are not so well borne, they are to be replaced by inunctions and compresses of oil. If suppuration of the glands occur in specially pernicious cases, this is to be treated

according to the rules of surgery. Preparations of iodine are to be used for the glandular indurations which sometimes remain.

General Treatment.

The treatment of diphtheria by internal remedies is based upon the same principles as those which guide the administration of internal remedies in other infectious diseases. As we possess no remedies which act directly to destroy or restrain the disease, or the virulent poison which causes it, we resort only, at the present time, to those agents which meet the existing indications. This mode of treatment has for its task, therefore :—

1. To diminish and ward off the general constitutional disturbances, the fever, and the different complications which are likely to arise, and which tend to keep alive the disease and to diminish the strength of the patient.

2. To increase the patient's powers of resistance, so far as this can be done by therapeutic and dietetic measures, in order that he may be able to live through the stage of reaction.

For this purpose, therefore, cooling and antifebrile remedies should be chiefly given during the commencement of the sickness ; these are, for instance, the mineral acids, dilute hydrochloric and phosphoric acids and solutions of the sulphate or the muriate of quinine in doses proportioned to the age of the patient and the vigor of the symptoms. If gastric symptoms usher in the disease, we can best quiet these by the administration of remedies containing carbonic-acid gas, such as the effervescing draught and various mineral waters. Where exhausting diarrhœa exists, we must combat it energetically at once, employing for this purpose, according to the intensity of the trouble, oily and mucilaginous substances in combination with varying doses of opium, or solutions of tannin, alum, nitrate of silver, etc. If on the second or third day the fever diminishes and all complications have been successfully brought under control, our best plan is to wait, and not to resume active interference until new, and then generally alarming, symptoms develop.

In some cases, already on the third or fourth day an alarm-

ing diminution of the patient's strength is observed; under these circumstances we must give the preference to excitant remedies. When the pulse becomes frequent and lacking in force, and the heart-sounds are feeble and indistinct, we may resort to the use of quinine in large doses (from eight to fifteen grains), and should this succeed in strengthening the heart's action—which, alas! is very rarely the case—we may then change to other tonic remedies. Still, even quinine may be continued for some time with advantage as a tonic, if administered in small doses of from three to four and a half grains in the course of the day. The stronger wines and nourishing diet, in the form of concentrated meat broths, soups to which the yelks of eggs have been added, tea and coffee, will also be found indispensable adjuncts. If under this treatment the patient does not recuperate, we may expect soon to see a still further depression of the vital forces, with indications of a pronounced sepsis, and symptoms of a fatal termination. At this point we may employ without hesitation large doses of the strongest irritants, as, for instance, sulphuric ether, Bestuscheff's tincture of iron,[1] and Cognac, combined with the stronger wines, in the hope of exciting the feeble and irregularly acting heart to energetic contraction. In adults, sulphuric ether or Bestuscheff's tincture should not be given in smaller doses than ten drops every hour, if we expect to obtain the desired effect; and where collapse has begun to show itself, the same dose, or even a larger one (from twelve to fifteen drops), should be given every half hour, not only during the day but throughout the night, or at least the greater part of it. Even in children and young individuals, where as an exceptional thing death has not been caused by suffocation through the blocking up of the larynx and air-passages, but is, however, threatening the patient's life through septicæmia, we should not hesitate to employ these same remedies. The dose must then, of course, be reduced so as to correspond with the age of the patient and the intensity of the disease. The English recommend the administration of large doses of Cognac in diphtheria under the same circumstances as

[1] Chloride of iron dissolved in a mixture of one measure of ether to three of alcohol. It contains one per cent. of iron.—*German Ph.*

those in which they have been in the habit of using it in typhus; and I have myself used it several times, with permanently good effects, giving in the course of a day, to an adult, from four to six ounces. Where Cognac alone does not seem to agree with the patient, it can be mixed with wine,—Bordeaux, for instance, or Carlowitz,—or with sweetened water, and given in conjunction with ether and Bestuscheff's tincture. In children it should be mixed with simple syrup or the syrup of orange-peel, in the proportion of one part of Cognac to two of syrup; in this shape it is borne well.[1] In severe forms of pharyngeal diphtheria it will sometimes be necessary, even in children only three or four years old, to administer in the course of a day as much as an ounce or an ounce and a half of Cognac. But the strong wines, such as Tokay, Port wine, and strong Bordeaux, also act powerfully upon the heart, and their use is therefore highly to be commended.

It is extraordinary what large quantities of ether and alcoholic beverages may be taken, even by children, when the septic influence of the disease has lowered the excitability of the central organs and enfeebled the action of the heart. On the other hand, it is of course clear, that if these be used prematurely and without judgment, their effect may be the very reverse of what is desired; they may greatly increase the frequency of the pulse and the temperature of the body, they may call into existence symptoms of irritation of the brain and spinal cord, or they may induce serious disturbances of nutrition by the gastric complications which they cause. The first appreciable improvement produced by these remedies shows itself in a diminution of the frequency and a greater regularity of the pulse, together with a more natural temperature of the surface, especially noticeable at the extremities; the pulse gradually improves in quality, is fuller and stronger; the sensorium, if previously clouded, becomes clearer,—and that, too, notwithstanding the enormous quantities taken of ether and alcohol, which, under ordinary circumstances, would have produced a very marked obscuration of

[1] Charles West, in the course of one day, once gave with good results nearly four ounces of Cognac and an equal amount of Port wine to a child four years old.

the faculties ; and, finally, the patient shows signs of returning strength and energy in all his functions.

If these manifestations of improvement are followed by genuine convalescence, we should, of course, gradually exchange these stronger stimulants for tonics like quinine, iron, and good nourishing diet ; but at first it is well not to give up the Cognac and strong wines altogether. As a rule, those patients whose constitutions have been deeply affected by the poison of the disease do not recover at once ; after the lapse of a short time, and generally while the urine contains albumen, secondary paralyses or other sequelæ occur, and necessitate further treatment and constant supervision on the part of the physician.

If, during the subsequent course of the disease, or even during the first few days, the patient manifests increasing signs of apathy and prostration, his pulse diminishing steadily in frequency, until it reaches perhaps the rate of from forty to fifty beats in the minute, and the temperature of his body falling to a proportionate degree, it is hopeless to expect any assistance from stimulating remedies ; neither ether, musk, castor, nor camphor will prove of any avail in averting death.

Treatment of the Secondary Paralyses.

The successful treatment of secondary paralytic conditions depends upon the possibility, first, of remedying the pathological changes produced by the disease, or at least of assisting Nature in her efforts to do this ; or, second, of retaining the functional powers of one organ until Nature herself shall have restored the integrity of a second organ, upon which the first depended for the maintenance of its proper functions.

So far as we have learned anything concerning the pathological changes which take place both in the central organs and in the peripheral nerves and muscular apparatus—changes to which the secondary paralyses are due—they appear to be of such a nature that in our treatment of the manifestations we are restricted to the last two possibilities mentioned above.

The milder forms of paralysis, where individual groups of muscles are affected, as those of the eye and the soft palate, get

well of themselves in a few weeks without any treatment. But in all cases where, besides the partial paralyses, there is anæmia and general weakness, iron and tonic remedies are indicated, in conjunction with nourishing diet, especially meat, wine, beer, and life in the open air (in the country, in the woods).

If the paralysis is more extensive, involving several groups of muscles, we may infer that the cause of it lies in some organic change of the brain or spinal cord—as, for example, capillary apoplexies, and disseminated myelitis; in such a case, recovery will depend on the possibility of a more or less complete retrograde metamorphosis of these changes. In deciding what our treatment shall be under these circumstances, we must bear in mind the possibility of increasing an already existing hemorrhage, or producing new ones in the brain or spinal cord by undue and useless interference. In this way it is possible to render the existing paralysis permanent, or even to cause new paralyses.

During the first two or three weeks, therefore, we should aim to give the patient rest and freedom from all excitement; we should put him on tonics and strong nourishing diet. For this purpose, administer quinine in small doses, and iron, together with tea, coffee, meat, light wines, a good quality of beer, etc. We are to resort to electrical stimulus only when new sets of muscles have ceased to become involved in the paralysis. We are then to apply either the induced electricity or the constant current to the muscles first affected, in order to counteract the fatty degeneration which is apt to take place when the muscles remain for too long a time inactive. When all symptoms of irritation of the central organs have ceased, convalescence can be still further hastened by the employment of warm brine or sea-baths, or—if the patient's means will not permit—warm sulphur baths, or baths to which common cooking salt has been added. For more detailed instructions regarding the electrical treatment, I must refer the reader either to the proper chapters in this handbook, or to special treatises on electro-therapeutics.

The use of internal remedies, with the exception of tonics, will exert no material influence, at least of a favorable nature,

upon the secondary paralyses of diphtheria; and nux vomica and strychnine—which last has been especially recommended in the form of subcutaneous injections—are the very remedies to be discarded here. These preparations cause the desired muscular contraction by acting upon the central organs, and if given in these cases in sufficient amount to produce this contraction, it will not only be difficult to avoid the effects of poisoning by strychnine, but we shall be pretty certain to cause such an irritation in the medulla oblongata and spinal cord as will almost necessarily aggravate those morbid changes which are the foundation of the paralysis.

Those cases in which the muscular paralysis seriously diminishes or entirely annuls the function of vitally important organs, require to be treated with very great care. The patient's life, for example, is in imminent danger when the palatine and pharyngeal muscles and those of the larynx are paralyzed. If the former alone are affected, the patient loses either in great degree or entirely his ability to swallow; if the latter are affected, he is not so much in danger from interference with the respiratory function, as he is from the liability to have particles of food pass into the bronchi and lungs during the act of swallowing,—an accident which is due to the imperfect closure of the glottis. To save the patient on the one hand from starvation, and on the other from the danger of having particles of food pass into the lungs,—which almost invariably leads to fatal pneumonia,—we should resort early, in such cases, to the use of the œsophageal tube for purposes of nourishment.

It surely is a very rare thing for paralysis of the muscles of the glottis, when not complicated by other troubles, to cause such a disturbance of the respiration, that the operation for tracheotomy has to be performed. Where the patient is quiet and his respiratory needs are moderate, there is usually room enough left in the opening of the glottis for all the necessary air to enter into the lungs. Even in cases where the posterior crico-arytenoid muscles (which open the glottis) are paralyzed, and their antagonists (which close the glottis) remain unhindered in their action, we never find—as I know from actual observation—the glottis so completely closed that respiration is either pre-

vented or even seriously disturbed, provided, of course, the patient remains quiet.

As regards the paralysis of other muscles,—paresis of accommodation, paralysis of the bladder, impotence,—they should be treated in the same manner as the other diphtheritic paralyses, with such modifications, of course, as are required by the difference in the organs.

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